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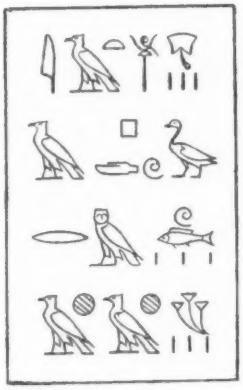

JULY · 1941
Vol. 5 No. 3

CONTENTS

The Mallard: Its Management in Western Montana ..... *George L. Girard* 233

A Sampling Technique for the Determination of Hunters' Activities and the Economics Thereof ..... *Seth Gordon, Jr.* 260

A Study of the Fall Food Supply of the Ring-necked Pheasant and the Bob-white Quail in Washington County, Rhode Island ..... *Thomas Wright, Jr.* 279

Factors Causing Rodent Damage to Tree Plantations in Southeastern Minnesota ..... *Lansing A. Parker* 297

Lymphadenitis in New York Cottontails ..... *E. L. Cheatum* 304

The Toxicity of Crotalaria spectabilis Seeds for Quail ..... *R. B. Nestler and W. W. Bailey* 309

White-tailed Deer Foods of the United States ..... *Earl L. Atwood* 314

Trends in the Kill of Wisconsin Whitetail Bucks, 1936–1940 ..... *William H. Schunke and Irven O. Buss* 333

Obituary 337

Note 338

The Wildlife Society

Report of the Secretary for the Year Ending with the Fifth Annual Meeting, February 18, 1941 339

Report of the Treasurer for the Calendar Year 1940 341

Report of the Committee Appointed to Audit the Annual Report of the Treasurer of The Wildlife Society for 1940 342

Report of the Editor for 1940 343

Report of the Membership Committee, 1940–1941 344

Report of the Committee on Professional Standards 344

Objectives in Civil Service 346

Report of the Committee on Arrangements 350

Minutes of the Fifth Annual Meeting at Memphis, Tenn., February 18, 1941 351

Officers, Committees, and Members of The Wildlife Society, 1941 ..... *Supplement*

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33
60
79
97
04
09
14
33
37
38
39
41
42
43
44
44
46
50
51

THE JOURNAL OF WILDLIFE MANAGEMENT

VOLUME 5 JULY 1941 NUMBER 3

THE MALLARD: ITS MANAGEMENT IN WESTERN MONTANA

George L. Girard

The mallard (*Anas platyrhynchos*) is, perhaps, first in importance of the game birds of the northern hemisphere. The purpose of this paper on the species is not to enumerate reasons for the depletion of its numbers, as they are reasonably well-known, but to describe a plan of management that can be used to assure its future.

In the capacity of manager of five small refuges administered by the Bureau of Biological Survey, the writer had an unusual opportunity to study the life history and management of this bird over a period of three years. The greater part of the information contained in this publication was obtained on the Ninepipe and Pablo Migratory Bird Refuges, areas of 2,002 and 2,540 acres, respectively, in Flathead Valley, Lake County, Montana. Management of the mallard is a year-round problem in that locality.

The writer wishes to thank Edwin Cisney who was a very valuable assistant in the field, as well as Stephen R. Bennett. J. Clark Salyer, II, and Edward H. Graham offered helpful suggestions with respect to this paper. Many sportsmen and private citizens also aided, particularly with the winter feeding operations. The National Youth Administration, the Works Progress Administration, and the Farm Security Administration contributed the labor utilized in connection with the experimental management reported in this article.

MIGRATION AND REACTION TO MANAGEMENT

During the three years, 1937–39, the fall migration of the mallard in Flathead Valley occurred between October 15 and November 18, the main flight usually coming between November 10 and 18. During that week, as many as 12,000 to 15,000 migrant mallards were recorded on a representative day at each of the small refuges mentioned. The spring migration was less marked than that of the fall, beginning about March 1 and continuing until about April 15. The main flight occurred between March 27 and April 3, when 8,000 to 11,000 new birds were seen daily at each refuge. There was a small but constant increase in the number of migratory birds each year of the period covered by this paper. Both in the fall and spring, mallards flew about considerably during storms and seemed to become very confused.

The mallard responded well to management. The number of nests on Pablo and Ninepipe Refuges increased from 81 in 1937 to 163 in 1938. Some of this apparent increase may have been due to intensification of study, though it is more likely that improvements in cover

on Pablo, and other advances in management on both refuges led to increased utilization of these areas by mallards. Observations during the spring of 1939 also indicated an increase of about fifteen percent for that year.

As further evidence of positive reaction to management, the August inventory, beginning in 1936, pointed to the following: An estimated total of 30,000 to 35,000 mallards in the Flathead Valley in 1936, 35,000 to 40,000 in 1937, 40,000 to 50,000 in 1938, and about 50,000 in 1939.

Lower Flathead Valley, including the Jocko and Moiese Valleys, is thickly dotted with numerous potholes which are very well supplied with desirable aquatic foods, and about one-third of the cultivated area in the valley or about 18,000 acres is planted to cereal grains. This valley would therefore provide an ideal habitat for several times as many mallards as now seek refuge there.

SPRING FEEDING

Spring feeding was tried in 1938 and 1939 on the Pablo Refuge. It was utilized in order to attract the birds to the more protected nesting areas and to bring about better distribution of nesting pairs. Investigation indicated that feeding led to the establishment of more numerous and better distributed nests on the refuge each year. While the advantages and disadvantages of spring feeding are not known for all areas, the writer's experience indicated that the practice is advantageous on newly developed areas that are deficient in vegetation.

COVER

Studies have been made in various sections of the country relative to the evaluation of cover types, and while they are interesting and informative, it is the writer's judgment that the results obtained are chiefly of local value. So far as the mallard is concerned, the main factor is an abundant and properly managed food supply. Ducks, particularly the mallard, will apparently adjust themselves to whatever cover is available.

As to cover, it appears that the important factor is quality. It is fortunate that a variety of types will serve since it is usually impractical to replant or change cover types. However, through observing the correlation of nesting locations and cover types, plans may readily be evolved for the improved distribution of cover and the better use of areas under management, resulting in increased productiveness.

The following cover preference report is based on observations on 267 mallard nests on the Ninepipe and Pablo Refuges during the nesting seasons of 1937, 1938, and 1939: Figure 1 shows the types of cover on the refuges and the percentage of mallard nests found in each. In some instances, the same plants were listed under classifications of both short and tall grasses, as soil and moisture conditions had retarded or stimulated the growth of the plants. In general, however, quackgrass (*Agropyron repens*), Kentucky bluegrass (*Poa pratensis*), fowl bluegrass (*Poa palustris*), timothy (*Phleum pratense*), bluejoint (*Calamagrostis canadensis*), western wheatgrass (*Agropyron smithii*), and cheat grass (*Bromus tectorum*) made up the tall grasses. Many weeds also were present. Thirty-three and three-tenths percent of the mallard nests were found in the tall grass cover.

Western wheatgrass (*Agropyron smithii*), Kentucky bluegrass (*Poa pratensis*), timothy (*Phleum pratense*), foxtail (*Hordeum jubatum*), and cheat grass (*Bromus tectorum*) were the principal species of the short-grass type. Twenty-six percent of the nests were found in this class of cover.

Thirteen and one-tenth percent of the nests were in thistles, including the Russian thistle (*Salsola pestifer*), the Canada thistle (*Cirsium arvense*), and the native bull thistle (*Cirsium macounii*). Eight percent of the nests were in cattails (*Typha latifolia*). Six percent of the nests were in "tumble-weeds," a term that refers to any weeds that become loosened and blow about, but particularly to the remains of the previous year's Russian thistles.

The Nootka rose (*Rosa nutkana*) had just been started on the refuges and in only a few instances had it grown enough to provide sufficient cover for nesting. The evidence to date indicates that grasses are decidedly the most desirable nesting cover.

The mallard seemed to be versatile in the selection of nesting sites. Although certain preferences are indi-

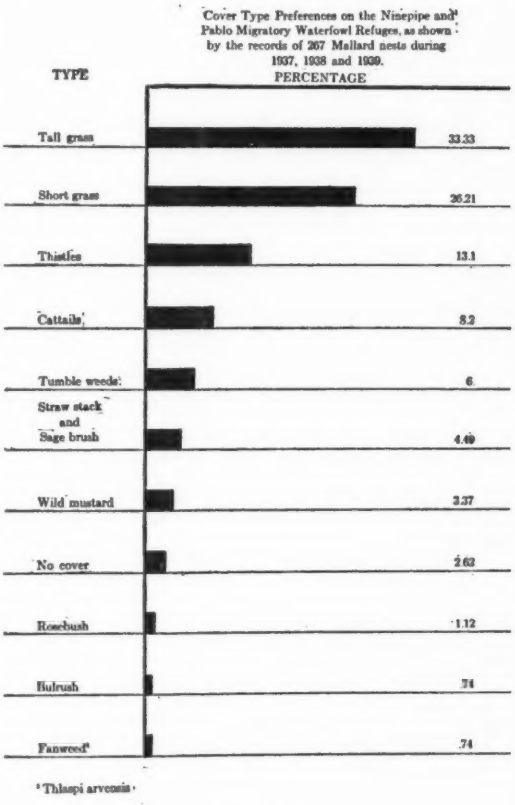

FIGURE 1

cated, nests were found in such types of cover as: Strawstacks, at the base of willows, in holes under cottonwood stumps, and in coverless rock piles. In single instances, nests were found under a binder, within an old tractor wheel, and on the roof of a Chinese pheasant shelter.

COURTSHIP AND MATING

A more thorough study is needed of the courtship and mating activities of the mallard. However, in western Montana during the last week of November some indications of pairing were noticeable, and by the middle of December the mallards appeared to be in pairs when resting and feeding and very often when flying. Peculiarly enough, however, courtship activities were not apparent to any great extent until late in January, the height of this activity occurring in the latter part of February. By March 15 the birds were apparently mated.

Continued study may determine the significance of the pairing of the mallards in the late fall. Do the courtship activities, which are so evident during the latter part of February and the forepart of March disrupt the associated pairs of the fall, or are they mainly confined to the younger birds?

At any rate, the courting period is characterized by some very interesting behavior on the part of the mallards. Noteworthy is head-bobbing; the male mallard apparently attempts to impress the female by bobbing his head up and down, and in a like manner she expresses her approval. In many instances, the manner of the male during courtship season is markedly violent. He may charge the prospective mate on the surface of the water, and ardently pursue her in mid-air, attempting to force her to descend to the water. Many battles occur among the males. The writer has observed as many as five males courting and fighting over one female. It is not unusual to see two or three drakes battling in mid-air in pursuit of a mate. None of the combats are of long duration, but in several instances drakes were observed to fight from three to five minutes in the presence of the female which, as a general rule, gives little heed to their actions. On some occasions, when she apparently prefers a certain drake, she will assist in driving off the intruder. The mating act invariably takes place in the water, and on some occasions is experienced by more than one male with the same female.

The courtship activities of the mallard indicate that the fittest and strongest males are the most successful in the selection of mates. Although added information is needed on this phase of the study, observation leads the writer to believe that if either sex of the pair of mated mallards is destroyed or dies no further attempt to select a mate is made for the remainder of that particular nesting season.

HONEYMOON OR REST PERIOD

With respect to mallards wintering in Flathead Valley the author would suggest that a portion of the life history may well be termed the "honeymoon." No definite date can be named as the beginning of the period but the majority of the mallards begin their honeymoon about March 15 and continue to about April 20.

During this period no nesting activities are carried on, and the birds are

notably content in each other's company. They appear to be merely idling and thoroughly enjoying themselves. The drake is exceptionally attentive to the female. As a general rule, he will not permit another mallard drake that gives any indications of interest to come within greeting distance. Sometimes the female will rout another female that ventures too close to her mate. On other occasions, both the male and the female will attack a mallard intruder. It may be interesting to mention that no attention is given to other species of ducks unless they become aggressive. Indeed, a happier pair of birds than the mated mallards during the rest period could scarcely be found. This season seems to give the birds an opportunity for intensive feeding, for scouting out the various potholes, and for selecting the place where the remainder of the summer will be spent.

The paired-off mallards during this period are not always alone but often collect in large flocks which may visit grain fields during the early part of March. The pairs, however, appear to remain invariably together even in these flocks. When they are congregated for flight or feeding purposes or on resting grounds, it is interesting to note that very little jealousy or fighting is manifest. Having passed through a rigorous winter and strenuous courtship, the species may build up resistance during the resting period in preparation for the nesting activities to follow. Any management program should provide an abundant food supply of both greens and grains for this season.

NEST AND LAYING OF EGGS

During the three-year period of this study, it was apparent to the observer that there are considerable variations in habits and actions of mallards. The average pair (267 observed) start selecting their nesting site and making the nest between April 20 and May 10. The nest is completed in a period of about 10 days. Nests averaged 118.67 yards from the water (varying from 1 to 500 yards). Every attempt was made by the writer to determine whether the male helps the female construct the nest. Nest work is exceptionally difficult to observe, but the indications are that the drake does not assist though he manifests a decided interest and may indirectly lend assistance.

For example, on May 2 at 8 a.m., a pair of mallards wandered up the bank into the grass. The drake walked erect with head held high, while the female seemed to glide through the grass, head down and body close to the ground. In a few minutes, however, the drake came back to the pond, swam about for a few minutes and disappeared again into the grass. On this occasion, he walked a short distance, stopped, looked about him in all directions, and again vanished in the tall grass. An hour and a half later the pair of mallards returned from the pond, drank, and disappeared as before. The drake held his head high as if keeping a look-out. The female glided through the grass ahead of him. About thirty minutes later the pair returned to the water but they appeared only to rest without feeding before leaving the water again. In short, they seemed to be intent on the task at hand. Their nesting site could not be seen by the observer.

An example of the guardian role of the drake was observed on May 3, 1939.

A pair of mallards were resting on the shore line at 8:30 a.m. At 9:45 they left the water and waddled to the bordering cover. The drake held his head high, but the female disappeared, and at 10:10 the drake came back to the pond alone. He was still waiting at the edge of the water at 11:50 when he noticed the observer and flew.

In several instances, the writer flushed females a hundred yards or more from water and on some occasions the males were with them. In one particular observation on May 4, 1939, a female mallard was flushed from a nest that had just been started. She was actually in the process of making the nest, which at that stage consisted of an unlined depression under a clump of dead Russian thistles. The completed mallard nest is very well constructed and is lined with down shortly before incubation begins.

During the three years' nesting studies the finding of nests definitely indicated that mallards prefer the shoreline bordering a small body of water; hence the importance of constructing water impoundments of a few acres, with long varied shorelines. The birds particularly like the margins of shallow bays. Success in rearing young is favored by small, protected bodies of water.

The height of the mallard laying season in Flathead Valley was between May 5 and 20. The general rule seems to be that the females lay their eggs in the morning or forenoon. Limited observations indicated that the female spent from one to one and a half hours on the nest when she laid an egg. As a rule, one egg a day was laid until the clutch was completed. The average clutch of eggs, a calculation made from 260 nests, was 7.13. The male appears to be greatly interested in the egg-laying. On many occasions a drake was seen to accompany a female to the nest, and as at nest-building time he walked with his head high, apparently on guard. In some instances he was seen to lead the hen to the nest when it was quite a distance from the water, and on other occasions he flew with the female to the nest. When females approached the nest by flying they alighted within a few yards of it.

While the female was laying the eggs, the male invariably guarded the shore line at the nearest point to the nest. The male often appeared to be sleeping, but immediately upon the approach of another mallard drake he became wide awake. Sometines he seemed to grow impatient while waiting for the female to lay an egg, and on a few occaisions flew close, circling over the nest as if checking on the female's presence.

INCUBATION

Records made for this study show that the incubating period of the mallard is about 28 days, varying two or three days either way.

Every attempt was made to observe the habits of the ducks in connection with incubation. Nesting observations indicated that the incubating females permitted themselves two feeding periods each day. Except when disturbed by unnatural conditions, the female, upon leaving the nest to feed, covered it carefully. She did this by walking around it, pulling the down and other available material over the eggs, and as a final step walking several times over its surface as if to pat it down. It was learned that as a general rule the feeding periods were in the early morning

from about 6:30 to 8:30 and in the cool of the afternoon and evening; in some instances the birds left the nest before daylight. Both periods consisted of about two hours each.

Several carefully observed females shifted their bodies on an average of about eight times during the day, carefully tucking the down lining of the nests up against themselves at each shift. However, towards the latter part of the incubation period, particularly when the eggs were pipping, movements were more frequent. For instance, one female mallard shifted 17 times in the forenoon during a period of about 4½ hours. In spite of the tediousness of their task, no females were observed to sleep while on the nest, but they were apparently alert at all times.

One female whose nest was on a strawstack bravely protected her nest from five crows by charging them in rapid succession. In one instance, a female was seen to attack a single crow that walked too near her nest; the startled crow flew immediately. Another female mallard attacked a squirrel that carelessly approached close to her nest; the squirrel also showed its respect by rapid departure. When a crow or a hawk flew over a female on the nest, it was noted that she invariably crouched lower and flattened her head on its edge. Even when the writer knew the location of the nest, this crouching and freezing of the female made it exceedingly difficult to find her.

It was also observed that the female upon leaving the nest during the laying season walked through the grass for varying distances and then flew to water. On other occasions, she walked the entire distance. Upon returning to the nest, she either slipped through the grass to the nest or flew within a short distance and walked the remainder of the way.

Until about the third week of the incubation period the drake continued to show interest exemplified during the forepart of the incubation period by sentinel duty along the shore line and before the nest and by his readiness to accompany the female during her feeding periods. On six different occasions, males were seen to rise and meet the female in mid-air. His patrol duty, very diligently executed, kept other mallard drakes away from his mate and nest. Ducks of other species, however, were not molested. In one instance, a marsh hawk, flying low, was observed to cross over a nest. The drake, which appeared to be asleep at his sentinel post, was galvanized into action, and charged along the surface of the water toward the hawk. Apparently the hawk had no malintentions toward the nest and flew on. The drake swam to shore and apparently went to sleep again.

In the spring of 1939 during the first week of the incubation period, a golden eagle snatched a female mallard from her nest within a distance of less than 25 yards from the writer. The observer rushed to the nest and the eagle dropped his victim. Although she died, her nest and eggs were not altered. Three days later the nest was again visited and found to be carefully covered with down and dry grass. Did the male in looking for his mate come back to the nest and failing to find her, or finding her dead, cover the nest, or was some other female duck responsible?

The interest of the male began to wane at the end of the second week of

incubation, and during the third week he sometimes permitted other drakes to idle within his domain. Moreover, he often slept and preened in the presence of other males at this time. In the first part of the incubation period he was present very early in the morning and throughout most of the day, but during the third week his visits were few. During the fourth week of incubation, it was rare to see the drake on sentinel duty. From about June 10 to June 20, the males began to concentrate on resting areas around the shore lines of islands and on peninsulas.

HATCHING PERIODS

About thirty hours elapses from the time the egg is pipped until the young mallard emerges. For example, on June 10 the six eggs in a mallard nest were starting to pip at 9:55 a.m. and were still only pipped at 9:30 p.m. On June 11 four of the eggs were still in the pipped state at 8:00 a.m. and the membrane of only one of the eggs was broken. At 7:30 p.m. on June 11, five ducklings had hatched, one being still damp, and the next morning before 8:00 a.m. the young ducks had left the nest.

On the basis of a total of 188 nests (Figure 2), for the spring of 1937, 1938, and 1939, on which accurate hatching records are available, the height of the hatching period was during the month of June in which eggs in 62.73 percent of the nests hatched. For the average mallard, the complete nesting period should be considered as between April 20 and July 20. However, to be on the safe side in management, the nesting season should be considered to extend from March 14 to August 18.

EGGS

Mallard eggs vary considerably in color. They are often creamy, or greenish-buff and in some instances show a slight tinge of pink. The most noticeable characteristic, however, of mallard eggs is the green or olive tinge. They are somewhat rounder than those of most ducks. Some difficulty in distinguishing mallard eggs may be had by the inexperienced worker, but practice results in fair accuracy; and flushing of the female insures certainty.

As incubation progresses, the eggs take on a more shiny appearance, and toward the latter part of the incubation period become slightly darker by virtue of the growing embryo.

Mallard eggs have considerable resistance to temperature variations and other adverse factors such as flooding. During the spring of 1937 in the first week of the incubation period a mallard nest was flooded, the water receding next morning. The female rebuilt her nest, raising it about an inch, and continued with her incubation. Five out of seven of her eggs hatched. In the spring of 1939, irrigation water flooded a nest for a period of 22 hours. Here again the female returned and raised her nest about an inch with a lining of dry, thick grass, and seven of her nine eggs hatched. Plate 17-A illustrates a typical mallard nest.

On May 23 a mallard nest on Pablo Refuge definitely in the shade on the north side of a strawstack, was partially destroyed during the first week of the incubation, and its contents of seven duck eggs and three Chinese pheasant eggs were scattered. The nest was rebuilt on May 25, and five duck eggs as well as three pheasant eggs had

A (*Upper*)—Mallard nest.
B (*Lower*)—Mallard duckling killed by a weasel.

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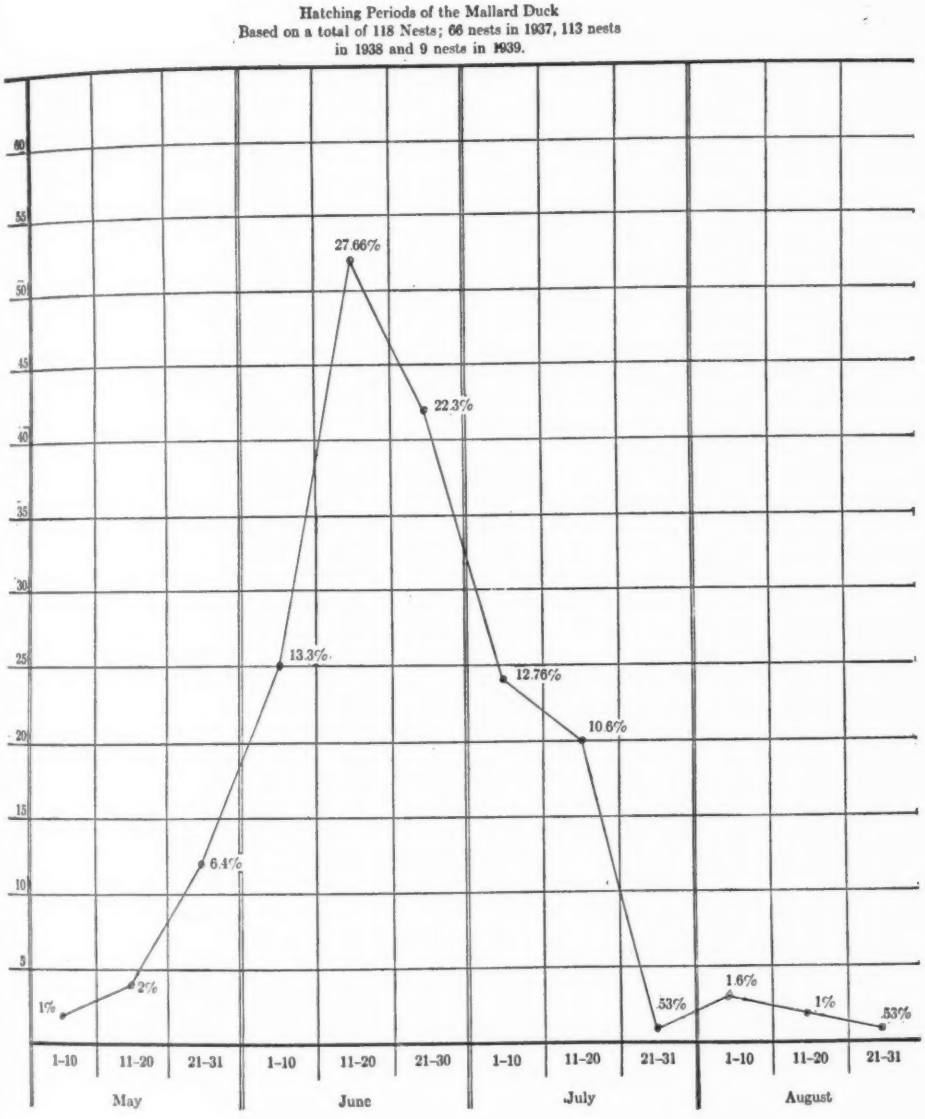

FIGURE 2

been replaced. The female was setting on the nest. The other three eggs were in holes in the strawstack from which apparently she was unable to dislodge them. Two of the five duck eggs hatched.

In two other instances during the spring of 1939 where the mallard nests were also in the shade, the female was kept from the nest throughout a day. This fact had no effect on the percentage of hatch of eggs as all the fertile eggs hatched. On June 6 a female mal-

lard was forced to leave her nest in the shade of a strawstack, between 8:20 a.m. and 1:10 p.m. Her well-pipped eggs were chilled, and the embryos stopped moving. However, seven of the eight eggs hatched, the eighth containing a dead embryo.

PREDATORS

Figure 3 shows the percentage of hatch and the known causes of failure to hatch. Of the total 1,797 eggs, 71.2 percent hatched; the cause of the destruction of eleven percent was unknown, 5.67 percent were destroyed by

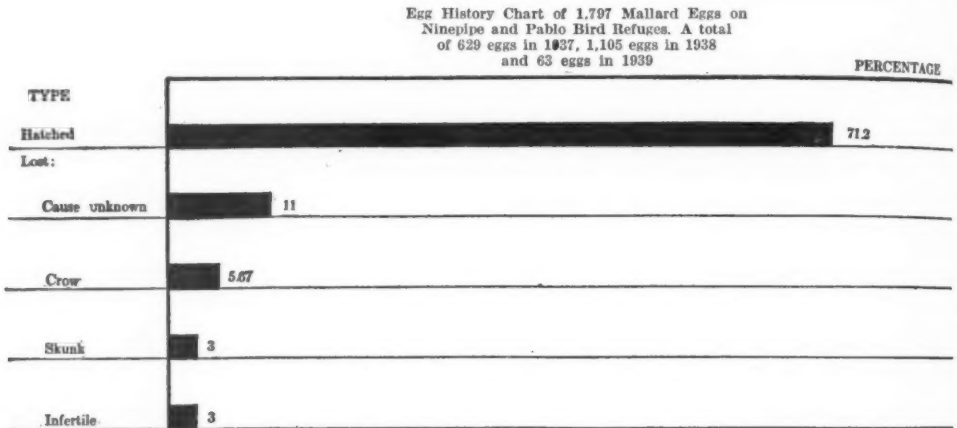

FIGURE 3

As a test in 1937, a clutch of eight mallard eggs were placed on a board in strong sunlight for an eight-hour period; none of them subsequently hatched. Protection of the eggs from direct sunlight normally is accomplished through choice of nesting sites in the shade and by the female remaining on the nest except for early morning and late afternoon feeding periods and by covering the nest when she leaves.

crows, and 3.2 percent by skunks, 3 percent were infertile, and 2.67 percent were deserted. Other causes of losses also are noted on the graph. A test used in this study to distinguish eggs destroyed by predators was explained by the author in the Transactions of the Fourth North American Wildlife Conference, 1939, in an article entitled, "Notes on the Life History of the Shoveler," pages 364–371.

It should be mentioned that in connection with the present study, crows, skunks, and weasels were diligently controlled before and during the nesting season. In the springs of 1937, 1938, and 1939, a total of 213 skunks and 98 weasels were removed from the two refuges. At least 47 coyotes also were taken from the refuges during the three years.

It is known that weasels kill young mallards and it was found that sometimes a weasel, before leaving a nest, would kill an entire brood. Plate 17-B pictures a dead mallard duckling that had been destroyed by a weasel; note the parts of the body attacked. This animal characteristically bites on the head and under the wing. As weasels often use ground squirrel's holes, their work has been blamed on the rodents. Unlike the weasel, the ground squirrel is more interested in the meat than the blood and usually will eat through any portion of the body to the entrails and consume them as well as the muscular parts. However, the Columbian ground squirrel found in western Montana was not observed to kill a young mallard. The fact that the predators were controlled on the refuges probably accounts for the small percentage of eggs destroyed. This indicates the place that control of certain predators should have in a management program.

Snowy owls visit Ninepipe and Pablo Bird Refuges in small numbers during their northern and southern migrations. On three different occasions owls of this species were seen devouring carcasses of mallards, but only in one instance was it certain that the owl had made the capture.

Individual golden eagles take mallards; such birds should be frightened away if possible, or if necessary, killed. During a period of about a month in the winter when the mallards congregated in large numbers in the feeding areas of Flathead Valley, a golden eagle stayed near and captured mallards at regular intervals. A certain golden eagle on Pablo Refuge became very persistent in its attacks on nesting birds, both upland game birds and migratory waterfowl. Shooting near him with rapid fire from a high-powered rifle for three successive days drove him away so that he failed to return.

This study indicated the unimportance for the mallard of the control of winged predators except possibly the crow. Control of four-footed predators for the protection of the mallard should be done only just before and during the nesting season, as if carried on at all seasons, it would result in loss of values from furbearing mammals that might easily outweigh any saving of mallards it might effect. It has been learned that skunks and weasels can be caught continuously on the refuges as they migrate in from outside areas, but control at any other time than the nesting season would be of very little value to mallards.

On many occasions, coyotes were seen hunting on the shore lines of the refuges, and doubtless they were responsible for some losses of mallards. They are known to destroy the nests of other game birds, but they were not difficult to control on these refuges and committed few serious depredations. It is felt by the writer that although coyotes do capture wounded and crippled birds that have managed to get to the refuge during the fall hunting season, no harm is thus done.

RESTING AREAS

The resting areas chosen by the mallards on these refuges were the shore lines of protected bays in the smaller bodies of water, and of peninsulas and islands in the larger water areas. Floating islands constructed of logs were used to some extent, but from the standpoint of cost and degree of usefulness to the mallard they are not recommended, except where natural islands are not present and it is impractical to build earth-filled islands. The most attractive shore lines were those that gradually descended into the water rather than those abruptly shelving.

Mallards usually confined their idling to the immediate shore lines not more than a few feet from the water's edge. Therefore, islands or peninsulas constructed for resting areas need not be wide but they should be built in an irregular manner, long and narrow, so that the greatest possible length of shore line is made available. Unlike diving species of ducks, the mallard is seldom seen far from the shore.

PLUMAGE

The young are hatched in what is known as the natal down. In four to six weeks, they begin to acquire their juvenile plumage but are not able to fly until they are about nine to eleven weeks of age. They have completed their first winter or mating plumage by approximately October 15.

As previously stated, the drakes lost interest in nesting activities after about the third week of incubation. At that time, from June 10 to 20, they began to congregate on the loafing areas. They were restless and easily disturbed during this period, but they flocked congenially. As early as the last week in June, flightless drakes were seen on both of the refuges, and from that time the drakes rapidly disappeared from the resting areas. Observations indicated that in this vicinity the period between July 15 and 25 is the peak of the pre-eclipse molt. More information is needed on this point, but the evidence is that this flapper stage lasts from two to three weeks, after which the drake appears in a plumage very similar to that of the female, though somewhat darker. In this eclipse plumage they remain not longer than three weeks to a month, and evidence of the second partial molt is presented by the appearance of spotted or blotchy males as early as September 1. By the first of October the majority of the males are well along with their winter (and mating) plumage, and about October 15 they are fully dressed in their beautiful and colorful attire. Males in this plumage are often referred to as green-heads.

On these refuges, cattail (*Typha latifolia*), and bulrush (*Scirpus occidentalis*), growths were most frequented during the eclipse plumage, but the birds were often found also in tall grasses near the shore line.

When approached during their flightless stage, they frantically flapped across the surface of the water and if pursued dove quickly beneath. Upon coming to the surface again, quite often they protruded only their nostrils and a portion of their head so that it was extremely difficult to locate them, particularly if any surface-floating plants were available in which they could hide. Diving seemed to tire them quickly. Although their flightless period placed them at a disadvantage, no observa-

tions were recorded of winged predators molesting them.

The female mallard does not enter her eclipse plumage until after the young are well along toward maturity, that is about 8–10 weeks after the drake has molted. Further information is needed, but limited observations indicated that the female produces her winter plumage much more rapidly than the male. It may be that it is not necessary for her to go through an intermediate partial molt as is the case with the drake. At any rate, the females in Flathead Valley are in full plumage by October 15.

FAMILY LIFE

Within twelve hours after hatching, the young are led by the female from the nest to the water. They follow her in single file and as this interesting little procession winds its way to the shore line the observer is reminded of the childhood game of "Pop the Whip." The young walk into the water after the mother, hesitate for a second, then follow her, swimming very rapidly.

The ducklings pass the first six weeks of their life in the close vicinity of the shore. Much of the time is spent on the immediate shore line, feeding in weeds or other cover that may be available. They consume many insects and feed from the surface of the water.

At the approach of danger when the brood is near the shore, the female's signal apparently instructs the young to hide in the grasses, but if the intruder approaches unexpectedly the female may swim rapidly off across the water, the young following her in single file. When the size of the young and the possible length of their swimming strokes are taken into consideration it is evident that they are exceptionally rapid swimmers. If the family is pursued too closely or man approaches unexpectedly, the young will dive while the mother attempts to decoy the intruder with numerous contortions as if her wings were broken. However, the shore line offers the chief protection for the ducklings, and whenever possible they seek it for safety.

The writer has seen mallards with broods of varying ages feeding in the grass back from the shore line. These occasions were not common but numerous enough to show that such cover should be carefully protected. During the spring of 1939 at about 9:00 a.m., a mallard and her six little ducklings were feeding about 200 yards from the shore line. It had rained heavily the day before, the grass was damp, and the grasshoppers sluggish. Careful observation revealed that this brood was feeding on the 'hoppers. Female mallards and their broods more often frequented the irregular shore lines of the smaller bodies of water, but in the larger bodies they favored the shores of peninsulas and islands.

These habits of the mallard families emphasize the importance of protecting shores from overgrazing. In western Montana cattle graze off first the grasses immediately bordering the shore line of lakes and potholes, while the rest of the pasture may not be greatly affected. Protection from grazing on nesting areas should be provided in that territory, therefore, at least eight or ten weeks beyond the hatching period. In fact, on nesting areas set aside for the mallard, cattle or stock should be removed as early as February

15 and not permitted to return until about September 15. This would result in minimum interference with all activities of the mallard preliminary to, and during, the rearing of the young, not only for the average, but for the early and late nesters as well. It may be stated that a strictly controlled late fall and winter grazing policy on a per animal per month basis would be very acceptable on areas managed primarily for the benefit of the mallard.

SURVIVAL OF YOUNG

Records show that the average hatch was five, and that an average of four young of each brood reached the flapper stage. This high survival was, without doubt, due in part to the care of the female mallards in raising their families. They very seldom ventured far from the shore and frequented mostly the margins of artificial islands, peninsulas, and protected bays.

Conditions for rearing the young were very favorable also because predators (coyotes, weasels, and skunks) had been controlled.

RELATIONSHIP TO CERTAIN OTHER NESTING SPECIES

Table 1 sets forth some interesting comparisons of the mallard with five other kinds of ducks. Notice that with the exception of the cinnamon teal, the mallard lays the smallest clutch. The percentage hatched varies little for all six species. This information obtained from less than 100 nests may not be entirely representative, although it is surely to some extent indicative.

With the exception of the ruddy duck, the months of June and July cover the height of the hatching season of ducks in western Montana. Fourteen redhead nests hatched in about equal numbers in June and July, while of the thirteen lesser scaup nests, ten hatched in July. The climax of the hatching period for the gadwall (18 nests) was largely in July, while that of the pintail (66 nests) was in June. Of all the ducks in western Montana, the ruddy duck is the latest nester. The laying season of this species, as well as hatching records for three nests, indicate that the height of the hatching

TABLE 1

NESTING SUCCESS OF THE MALLARD COMPARED WITH THAT OF FIVE OTHER DUCKS

Species	*Total nests*	*Average number of eggs per nest*	*Percentage of hatch*	*Height of hatching period*	*Average distance from water (yards)*	*Nearest to water (yards)*	*Greatest distance of nest from water (yards)*	*Average hatch per nest of nests that hatched (eggs)*	*Percentage of eggs destroyed by crows*	*Percentage of eggs destroyed by skunks*
Mallard	252	7.13	71.2	June 63.72%	118.67	1	500	5	5.4	3.28
Shoveller	132	8.6	60.60	June 73%	72	2	370	6	5	3.5
Blue-winged teal	107	8.27	71.77	July 53.83%	81.3	2	500	6	4	3.38
Cinnamon teal	22	6.2	72	July 68.8%	60.6	3	220	4.7	3.5	5.59
Baldpate	45	9.55	74.88	July 51.2%	98	2	350	7.15	4.6	3.13
Green-winged teal	15	7.53	75.2	June 69.2%	34.2	4	100	5.66	4.4	0.0

period is in the forepart of August.

The peak of the hatching period for two upland game birds, the Chinese pheasant and Hungarian partridge, was during the month of June.

The crow and skunk, the two predators which in this study were found to be most destructive, seemed to show little preference among the various duck nests.

It can readily be seen that any management program for the mallard that includes improvement of cover, removal of livestock, and the control of predators also improves conditions for other game birds, including upland species.

It was found during the three spring nesting studies that about one out of every twenty mallard nests contained one or more Chinese pheasant eggs. In other words, six out of approximately 120 mallard nests held such eggs. Out of each twenty of these eggs, an average of about four hatched. The presence of these foreign eggs apparently interfered little, if at all, with the mallard's activities. No mallard eggs were found in the nests of other ducks. The mallard, as well as other species on the refuges, often nested undisturbed within a few yards of short-eared owl nests.

It should be pointed out that there is considerable variation in the habits of the different species even if in general they are similar. For example, the mallard drake, as previously stated, is very much interested in nesting activities until about the third week of incubation, while the shoveller drake maintains interest through the latter part of the incubation period and is on hand to meet his new family. He does much to assist the female in rearing the young for the first two or three weeks before he begins to associate with other males on resting areas.

The American coot's nesting habits in no way interfere with those of the mallard, but observations in this study have indicated that in some instances coots will attack very young ducklings. Although the coot has a pointed bill and during seasons other than the nesting period is readily able to chase a mallard out of its path, a female mallard while raising her brood will without hesitation attack a coot and usually with success. It is not to be inferred from this report that the American coot is responsible for any important destruction to ducklings, but the observations are mentioned here merely as an item of interest. As a general rule, the mallards and coots keep their families apart.

YEARLY ACTIVITIES

Beginning about August 15, the mallards in western Montana feed in cereal stubblefields. At this time and until the hunting season, they congregate in rafts[1] at about 2:30 p.m. Before leaving in large flights, the mallards bunch together, a great deal of chattering takes place, and the largest flights leave between 3:00 and 6:00 p.m. Before the hunting season, it is not unusual to see mallards feeding at any time of the day in the wheatfields, but most of the field feeding takes place in the evening and at night. The largest flights return to the water between 7:30 and 8:30 a.m. During the hunting season, with legal shooting hours from 7:00 a.m. to 4:00 p.m., mallards practically all return to

[1] Rafts refers to flocks of birds bunched closely together on the surface of the water.

the water areas between 6:30 a.m. and 7:15 a.m., and leave in large flocks between 4:30 and 6:00 p.m. After the hunting season, as previously described, they again change their habits, and continue field feeding throughout the winter until about the middle of March.

The feeding habits of mallards are somewhat altered by weather conditions in winter. For example, when the fields are covered with a thin layer of snow and frozen at night, particularly in the late fall and mid-winter, mallards are not able to feed at night. The crust formed on the snow makes it impossible for them to get the kernels of grain, which in this valley is mainly wheat. When such conditions prevail therefore, the ducks are found on the water at night and throughout the forenoon. As the day grows warmer and the crust softens, they again visit the fields, remaining during the afternoon and evening until the lower night temperature again renders the grain inaccessible.

Dependent upon weather and snow conditions, the mallards graze in fields, beginning during the latter part of February and continuing throughout March. During this season, however, they are also seen at times in the stubblefields. Field grazing is mainly on the early spring growth of fall wheat and seems to be limited to a period of less than thirty days. Beginning the latter part of March and continuing throughout most of April, it was not unusual to see mallards feeding on greens available along the shore lines and back from the water's edge. On Ninepipe and Pablo, the chief plant sought was water spikerush (*Eleocharis acicularis*). Shore line grazing was practiced quite extensively also by spring migrants.

Throughout the months of May, June, and July, mallards are practically dependent for their food supply upon water areas that harbor aquatic plants and insects. During these three months no field feeding and very little shore line grazing was observed.

To illustrate the relationship of the daily activities of the mallard to shore line and water, observations were made and recorded for the month of April as shown in Table 2. This table indicates the various activities carried on by the mallard throughout daylight hours. It should be explained that the numbers shown in the table are not the total number of mallards on the refuges but rather those counted in connection with

TABLE 2

ACTIVITIES OF MALLARDS RECORDED ON PABLO AND NINEPIPE REFUGES DURING THE MONTH OF APRIL, 1939

Time	A.M. 7–8	8–9	9–10	10–11	11–12	P.M. 12–1	1–2	2–3	3–4	4–5	5–6	6–7	Totals
Resting on water	2	77	202	297	481	32	2	145	983	43			2,272
Resting and preening on land		179	174	152	1	120	123	138	58	293	124		1,362
Sleeping on water			4		6			12					22
Swimming	6	92	103	91	427	8	2	12	137	46	5		929
Standing on land	5									3			8
Flying over surface of water	10	34	5	1				10	5		70		135
Mating		2		2	4								8
Fighting		8	4	3	4				6				25
Feeding in water	180	41	176	88	4		141	334	122	377	10		1,413
Grazing adjacent to shore	47	98	2		6	8	10	10	267	769			1,217
Feeding and resting on land adjacent to shore	25	90							1,175	705			1,995

certain activities at that particular time of day. Only those ducks were included that were apparently unaware of the presence of the observer. With this factor taken into consideration, the number of birds listed on the table appears to be a fairly representative group. The importance of the land as brought out in the record of daily activities further stresses the need of numerous islands with sloping shore lines. The writer had anticipated that these observations would indicate something of a daily routine for the mallard, but the opposite seems to be the case.

FOODS AND FOOD AREAS

In lower Flathead Valley where very careful observations have been made, practically all the valuable water feeding areas for mallards fluctuate in level. The potholes that are well filled during the spring and irrigation season later evaporate and in some instances go almost completely dry. The two refuges, Ninepipe and Pablo, are storage reservoirs, but the development program has established permanent potholes around the borders of the main reservoir on Pablo. When full, Ninepipe has in addition to the main body of water about 40 separate depressions that remain filled when the reservoir lowers. However, all potholes and newly developed pools on both refuges vary considerably in their water levels during the year. All the aquatic plants found in them, therefore, are species able to adjust themselves to that condition.

The mallards in this valley showed a decided preference for certain aquatic plants. Observations indicated their importance as follows: Sago pondweed (*Potamogeton pectinatus*) heads the list, with leafy pondweed (*P. foliosus*) and small pondweed (*P. pusillus*) jointly second; third, smartweed (*Polygonum amphibium*); then widegon grass (*Ruppia maritima*); redhead grass (*Potamogeton perfoliatus*); muskgrass (*Chara*); and duck weeds (*Lemna minor* and *L. trisulca*).

Horned pondweed (*Zannichellia palustris*) is present in such small quantities that it was of little importance, but one pothole having a dominant stand was a favorite feeding area of the mallards. The duck potato (*Sagittaria arifolia*) that grows in lower Flathead Valley is present in some areas and is dominant in a few places, but was very little used by the mallards.

An unusual little plant, water spikerush (*Eleocharis acicularis*) is very prevalent in lower Flathead Valley, being found on practically all areas where the water has receded. During short periods when taken from the surface of the water by mallards, it appears to be a very desirable food. This is explained by its interesting life history. It starts growth on the bottom of the reservoir sites and in potholes where the water levels vary constantly, and when the water recedes it blooms and goes to seed. But when the bare areas are again flooded, particularly if wind and subsequent water movements prevail, the plants dislodge from the bottom in large quantities and rise to the surface. The mallards relish them greatly, seeming to prefer the roots and seed heads. If the flooded area is not too deep, the ducks can also be seen uprooting some of the plants which then rise to the surface. This plant should by all means be transplanted to muddy-bottomed areas where water levels fluctuate.

Another group of aquatic plants which are of importance in the feeding habits of the mallard are those that may not be themselves consumed but which harbor many insects and other food organisms. In Flathead Valley the foremost of this group was water weed (*Elodea canadensis*). Judging from the number of mallards that fed in the areas where it is dominant, its value is nearly as great as that of the very desirable duck foods heretofore listed. This was particularly true in lower Flathead Valley where it was extremely abundant. It was found to some extent in every pothole, and in some areas was the dominant plant. In this region the following plants had a value similar to that of water weed: coontail (*Ceratophyllum demersum*), water milfoil (*Myriophyllum spicatum*), crowfoot (*Batrachium trichophyllum*), and the white water buttercup (*Ranunculus aquatilis*). However, the last-named plant apparently has some food value in itself.

Mallards seemed greatly to prefer newly flooded areas. This was true even when such plants as foxtail (*Hordeum jubatum*), salt grass (*Distichlis spicata*), thin grass (*Agrostis diegoensis*), reed grass (*Calamagrostis neglecta*), flat sedge (*Cyperus inflexus*), and cheat grass (*Bromus tectorum*) were suddenly flooded. In such areas, the observer would be at a loss to determine the nature of the available food supply for mallards, although the birds flocked there in great numbers. They also fed on newly flooded spots that appeared to be barren. They particularly preferred, however, areas harboring such plants as water spikerush (*Eleocharis acicularis*), duck millet (*Echinocloa crus-galli*), tall spikerush (*Eleocharis palustris*), and cereals such as wheat, barley, oats, and rye. As aquatic plants are usually not plentiful in the early spring and late fall, a management program would best assist the mallard by providing extensive newly-flooded areas in those seasons.

In western Montana wheat is the chief grain involved in the field feeding habits of the mallard. However, the birds were seen to feed also in barley, oats, and rye fields. Lower Flathead Valley has a seed-pea warehouse, and the fields on which the peas were raised were exceptionally attractive to the mallards. Their value ceased, however, when the farmers plowed or disked the pea fields early in the fall.

From the latter part of March to the end of April on areas where the water had receded (as indicated under "Yearly Activities") mallards grazed to some extent on the greens available along the shore, particularly on water spikerush flats. They also used areas where orache (*Atriplex hastata*) and goosefoot (*Chenopodium murale*) were dominant the previous fall. Spring grazing also included green cereal fields, the chief attraction being areas of winter wheat.

In western Montana the potholes and reservoir sites are usually frozen during the forepart of November, and from this period on when mallards are not feeding in the fields they frequent the open streams and the warm spring areas. The streams in lower Flathead Valley offer both sago pondweed (*Potamogeton pectinatus*) and other pondweeds (*P. foliosus* and *pusillus*), as well as redhead grass (*P. perfoliatus*), and muskgrass (*Chara*). In some instances, water weed (*Elodea candensis*) is found in the slower-moving waters. These plants are all

very desirable, and as the winter progresses they appeared to be completely removed by the mallards. As the critical winter period approached, water cress (*Sisymbrium nasturtium-aquaticum*) also was stripped from the streams, including all of its root stalks that could be worked out of the mud. In fact, the water areas become almost barren of any green substances, including algae. Seeds, winter buds, etc. were left, however, to renew the growth.

GRIT

The writer experimented by supplying piles of sand and found that they were used by mallards most extensively on the exceptionally muddy shore lines of islands and peninsulas. Islands covered by, or constructed of, gravel and sand should be attractive to mallards, particularly if located in feeding areas of very muddy bottoms where natural grit is lacking. In fact, many feeding areas can be greatly improved by the introduction of grit. This step might also be a means of decreasing the consumption of shot pellets and in this way help to control lead poisoning.

FARMING PROGRAM

From the discussion of "Yearly Activities," the reader will realize that the mallard during eight months out of the year in western Montana is primarily dependent upon farm products for food. It is thus apparent that any plan to propagate mallards which fails to include a farming program is inadequate.

During his stay on the Pablo Refuge, the writer shaped a farming program to meet the requirements of mallards, Chinese pheasants, and Canada geese. The farming was done on 318 acres, 118 of which were used each year. Eleven small food patches distributed around the entire refuge account for the odd 18 acres.

One hundred acres of summer fallow was planted to winter wheat and this was grazed extensively during the fall by the geese. In the spring the same field provided grazing for mallards as well as the geese. While this hundred acres was summer-fallowed, a second hundred was maturing a crop of winter wheat, most of which was harvested. Five plots about two acres each in size were left standing in this field as food patches, and five acres of the wheat were cut with a binder and stacked. The remainder of the harvesting was done by the combine in such a manner that considerable waste occurred. The harvested crop, varying from 15 to 25 bushels per acre, was stored in steel granaries for later use in feeding. As soon as harvest began, the Canada geese started to feed in the stubble. They systematically worked the field but were never seen feeding in the standing wheat left in the food patches. Chinese pheasants also fed in this field and the mallards joined during the month of August. If this were the only field on the refuge maintained for mallards, the geese in their systematic feeding would compete too heavily with the ducks. However, a third hundred acres was permitted to volunteer; sample cuttings indicated that its yield varied from two to five bushels to the acre. This hundred acres was not cut during the late summer or early fall, and during this time neither ducks nor geese fed there.

The eighteen acres, divided into eleven food patches was planted to spring wheat that matured later than winter

wheat and was ready to cut during August. Most of these small food patches were surrounded on two sides by snow fences. Half of each food patch was cut, but the grain was left lying on the ground. It was noted that while geese fed to a certain extent on the wheat cut in the food patches, they preferred stubble not bordered by snow fences; that is fields in the open. Mallards, however, fed extensively on this cut-down wheat throughout the latter part of August and during September until it was largely consumed. Later in the fall, Chinese pheasants apparently were still able to find good feeding in these areas, as they used them after the mallards had abandoned them. It should be noted that there was a pheasant shelter adjacent to each food patch.

Mallards did not start to feed in standing grain until the latter part of October and the forepart of November, and on Pablo Refuge they invariably selected the volunteer stand; this was intermingled quite thickly with wild mustard. Mallards seemed to prefer to feed in large flocks, which may account for their choice, since the larger field of volunteer wheat more readily accommodated them. In any event, the small standing food patches that were adjacent to the shelters and snow fences were disregarded at this period. They were used later in the winter by both mallards and pheasants when accumulations of snow made the plant heads accessible. About November 10, approximately half of the hundred acres of volunteer wheat was cut down to offer an attractive feeding area for the migrating Canada geese as well as for the mallards.

Two of the five food patches left in the hundred acres of harvested winter wheat were flooded during the forepart of October. Thousands of mallards visited these areas. The fifty acres of volunteer wheat and the other three food patches which could not be made available for flooding were left standing. These were frequented mainly by mallards during December when the snow covered many stubblefields throughout the valley. At this time and during January, mallards used the standing spring wheat food patches adjacent to the pheasant shelters. This was not objectionable since threshed wheat placed in self-feeders took care of the needs of the Chinese pheasants during the critical winter period.

The bundles from the five acres, which were cut with the binder, were placed in small, loosely-constructed stacks about eight feet high. It was found that mallards visited these small stacks extensively, particularly during the hardest part of the winter, the latter part of January and the forepart of February. Pheasants also fed continuously on these open-bundle stacks. Under this method, there seemed to be no way to control competition between these two species, but geese in no instance fed on the stacks. During the latter part of February, most of March, and during chinooks (warm winds) that may occur throughout the winter, the standing wheat and the stubble became available, and the mallards visited the fields in large numbers.

This farming program was arranged to provide food throughout the fall, winter, and spring, and could have been much simpler had it not been necessary to provide for the Chinese pheasants and Canada geese as well as the mallards.

The farming program on Pablo also included a five-acre corn patch that was used to furnish corn in the field for Chinese pheasants, and harvested corn-on-the-cob for both pheasants and mallards during certain periods in the winter. One acre of peas was cultivated as an experiment in 1939; during the month of August, before ripening, the peas were entirely consumed by mallards and pheasants that flocked to the field in unusual numbers. The apparent desirability of peas was off-set, however, by their high cost.

The reader may feel that a liberal farming program may encourage mallards to spend the winter in areas not suitable for them. On the other hand, the program was set up with reference to existing habits of mallards in western Montana where the birds have wintered during all past years in which records have been kept. This area is unique in that it is usually visited by chinooks throughout the entire winter. But whatever the reason may be, the mallards do spend the winter in western Montana and their management thus becomes a year-round problem.

Due to the wide range of the species, management of the mallard is a nationwide program. Hence farming operations to provide food should be carried on at numerous points along the migration routes of this duck. Emphasis should be given to an early spring and late fall supply of food in the northern and to a winter supply in the southern wintering areas. The point to be stressed is that merely providing nesting, resting, and wintering areas without a properly adjusted and managed farming program probably will not, over an extended period, restore mallards in large numbers. In fact, such an unbalanced plan might eventually decrease its numbers through increasing competition with other waterfowl that do not feed in cultivated fields.

WINTER FEEDING

Winter feeding of game birds in the northwest, particularly of mallards and Chinese pheasants, is a much discussed topic. Wholesale winter feeding of mallards or any other game species is not advisable. The feeding should be confined to that short period in winter when practically all water feeding areas are completely frozen over, and the few remaining warm springs or streams have been stripped of their natural foods. Even, then, feeding is not necessary if the territory lies in a farming area where wheat or pea fields are not covered with more than four or five inches of snow. But when the mallards are faced with severe winter conditions with the wheat- or stubblefields covered with 12 to 18 inches of snow and the temperature below zero, a serious situation prevails and man must come to the rescue.

Game managers working in the field with birds in that portion of the United States which is visited by severe winters are rapidly learning that game populations—big game or any other species, even when environmental conditions are favorable during the remainder of the year—are largely controlled by critical winter periods.

Some observers who have spent much time studying diseases and parasites of birds and who have had very little experience with their actual management state that only the weakened and parasitic individuals die from starvation dur-

ing the critical winter periods. Some believe that pathogenic conditions may be responsible for the failure of mallards to go far enough south to insure their winter food supply, and add, "Let us disregard them since they are poor breeders." Others interested in this work have advanced the opinion that if the birds are assisted during critical periods they soon become dependent on man and as a consequence lose their hardiness.

Formerly, the author was likewise opposed to winter feeding, but he has learned that man, on the whole, cannot change the natural habits and tendencies of wildlife. He must study these habits and tendencies and adjust management programs to them. The tendency of mallards to remain in some portions of the winter-bound areas of this country is a factor that man cannot control. He appropriates and spends large sums of money to propagate mallards, so if a few hundred dollars will prevent the starvation of thousands of mallards, what conclusion must be drawn? Is it to be considered good management to allow 50,000 mallards to perish for want of assistance during critical periods, and then to spend large sums of money in raising the same number? It is the writer's belief that birds able to withstand the rigorous climatic conditions to which they are exposed of their own free will may even be stronger and better breeders when spring returns, particularly if the winter does not happen to be too severe and a winter food supply can be found. Winter feeding insures the fit condition of breeding stock for the nesting season.

Careful observations on the part of the writer and of those assisting him throughout a three winters' period have brought out the fact that mallards and Chinese pheasants will not permit themselves to become paupers. The coming of a chinook, melting and softening the snow covering the stubblefields, reduces in one day's time a congregation of 7–8 thousand mallards on a feeding area to a mere handful of 3–4 hundred. Apparently, the birds prefer to rustle their own food when conditions permit. Although it was necessary to winter feed the mallards, the number wintering here (between 35,000 and 40,000) remained about constant for the three years. In other words, feeding did not lead more birds to stay in winter.

Winter feeding should be directed by experienced individuals who are familiar with the habits of the wildlife species concerned, with the climatic conditions of the area, and with the usual numbers of birds remaining there. Game managers should be certain that the winter program is begun, neither too soon, nor too late. Close observations in western Montana indicate that mallards can withstand severe conditions with very little food for a period of about three weeks, but after that time will die in large numbers. This factor should be taken into consideration, and winter feeding programs should be organized in such a manner that they can be brought into effect on time.

Sportsmen's organizations are usually quick to rally with assistance in cash and field help but they should always consult the game manager before starting a program of their own. Sometimes overenthusiastic sportsmen turn out in large numbers without centralized leadership and scatter feed indiscriminately in any open water they may be able to find. As a result, their efforts

are largely wasted. Very often excess feed is placed in some areas and an insufficient supply in others, or the wrong type of waters may be selected, possibly too deep or too muddy. Such winter feeding is hardly worth doing. Although sportsmen are very willing helpers, usually none of them can give their full time. If the game manager has an ample supply of stored food produced by a farming program such as that described in this paper but lacks field assistance, the sportsmen's ready cash and energy can be best utilized to provide such help. In most areas, the critical winter period does not last more than from two to four weeks. The writer has learned that a few full-time men operating under a well-organized program can do much more thorough work than can be performed by many assistants on a part-time basis.

Selection of feeding sites should be based on a thorough knowledge of the territory, of the general flight lanes, and of the feeding habits of the birds. In Flathead Valley, most of the winter feeding of mallards has been done in water areas large enough to accommodate several thousand ducks. The water should not be over 18 inches in depth and should have a sandy bottom. Larger numbers of mallards are better served by using fewer and well-adapted areas rather than numerous smaller, scattered areas.

In some instances in rather large territories, all water areas may freeze except rapid rivers that cannot be used for feeding. When no suitable water feeding places are available, snow feeding areas may be used. The following method was found to be suitable: The snow was shovelled off to form trenches six feet wide, their length varying with the number of mallards to be fed. The birds readily adopted these snow-trenches during the critical period.

However, water feeding is far more desirable. Sandy bottoms furnish grit, but it was found that piles of gravel placed around muddy-bottomed feeding areas were extensively used as sources of grinding material. When natural grit is lacking, it is desirable to feed grit along with grain.

Feeding corn-on-the-cob also was tried in western Montana. When it was broken up into small pieces and fed in still or slow-moving water it proved to be quite satisfactory. Removal of the kernels from the cob required activity on the part of the mallards and in many instances several of them would struggle over one cob. When the weather is 30°–40° below zero, such activities are undoubtedly beneficial, but since the birds are usually in a somewhat weakened condition at the time, nubbined corn should not be used alone. Some of the less resistant birds may be crowded out and fail to receive their proportionate share of the food. Using wheat, the smaller kernels can be equally spread over the feeding area.

Losses of mallards were negligible when an ounce of wheat per bird per day was fed during the winter. Five-gallon wooden pails or canvas bags that could be strapped to the shoulders proved to be very satisfactory as containers to use while scattering the wheat.

PRIVATELY OWNED LAND

In planning for the future of the mallard, disregard of the private landowner would be a grave error, as due to its feeding habits the mallard is necessarily

associated with farms and farming activities. For example, as previously mentioned, in western Montana the mallard feeds in fields about eight months out of the year. The small and numerous springs, potholes, lakes, and streams, located on private land, also are usually excellent breeding habitats for the mallard. Although each pothole is limited in its breeding capacity, the fact that only a few pairs are present may lead to better survival of the young. Numerous reservoirs and stock-watering ponds constructed by private landowners also offer a haven for mallards.

The private landowner also controls the stock industry of the nation, which through grazing, may vitally affect wildlife. Properly deferred or rotated grazing practices on these lands may be correlated beneficially with important phases of the life-history of the mallard. For example, desirable nesting areas might be used as late fall or winter, instead of spring, pastures. The haying industry, particularly that of the wild crop, if carried on in disregard of wildlife preservation can raise much havoc with the nesting of mallards.

State game and fish commissions and biologists should point out the value of aquatic environments as muskrat marshes and fish ponds in yielding crops for the farmer. Either of these habitats provide suitable conditions for mallards. In fact muskrats in particular should be encouraged in any management plan for the birds. These fur bearers were not observed to interfere with mallards and their run-ways through dense shore line cover as cattails and bulrushes do much to make these dense covers more usable for mallards.

Farmers should become acquainted with the value of aquatic plants in maintaining a pure supply of water in their stock-watering ponds. Fencing off water holes and ponds is one of the accepted methods of controlling the spread of the liver-fluke found among cattle and sheep, and it helps mallards by protecting their nesting cover.

Many farmers have reported to the writer that they consider the field feeding of the mallards of value to them through removing wheat kernels which might otherwise produce undesirable volunteer plants. Mallards do not damage crops as they do not start their fall field feeding until after the harvest. Their spring grazing activities are limited, are confined to winter wheat, and are believed to be beneficial to the crop. In the three years' association of the writer with farmers in western Montana, only one complaint of the spring grazing habits of mallards was made. This farmer sowed his wheat in stubble without plowing, and then when he harvested the wheat reported that the mallards were responsible for the poor crop. The writer was not notified during the spring when the grazing took place

One of the greatest possible benefits to the future welfare of mallards, and to which the sportsman can readily contribute, is the bringing about of better farmer-sportsman relations. This will do much to forward game management on privately-owned land. Sportsmen should make every possible attempt to set up cooperative arrangements with farmers, whereby they will be permitted to plant suitable foods in the water areas and the farmers will be allowed to realize a cash value for the mallard

crop. With that incentive, farmers would probably place more restraint on the activities of pet animals, such as cats and dogs which often prove to be the worst predators on the farm.

HUNTING

From the standpoint of distribution and number of its hunters, the mallard is doubtless the nation's most important game bird. It provides every feature the hunter desires—speed of flight, craftiness, and sturdiness. Who would think of hunting pheasants in a typical northwestern blizzard? The pheasant would be well hidden for its own protection, while the mallard braves all kinds of weather. And for the man who likes to face nature at her worst, the hunting of mallards offers sufficient justification for his fancy, and provides keen excitement for the best of hunters. Those who have not felt their blood tingle, while laying in wait on a cold, sleety morning in November watching for a flock of mallards to venture within shooting range, have not "lived," according to many a hunter of ducks.

For the hunter who prefers a variety of approaches, the mallard is ideal. First, through their fall migration and on flights between bodies of water and from water areas to field feeding sites, they offer "pass shooting." The problem of the hunter in this type of shooting is to locate the flyway of the birds, construct his blind, and make his shots as birds fly swiftly by. Second, for the hunter who likes to do considerable hiking, the mallard offers excellent "jump shooting" about lakes and potholes and along rivers and other streams. Third, like upland game birds, mallards can be hunted in fields because of their habit of feeding on waste grains. In some instances, it is necessary to crawl considerable distances to get within gun range of mallards feeding in fields. Hunters who classify themselves as sportsmen certainly will not shoot mallards "on the set" but rather will always give them a sporting chance, permitting them to take flight before shooting.

The mallard is such an attractive game bird that hunters' and sportsmen's organizations often establish duck hunting clubs and congregate at these headquarters each fall.

The manufacture of varied types of equipment needed to successfully hunt mallards, as well as the utilization of gasoline, oil, hotels, and meals by the hunters constitute no small industry and is another reason why conservation of mallards is a serious concern of the nation.

NATURE LOVERS, TOURISTS, AND VACATIONERS

When we visit a lake or stream we unknowingly do so in order that we may become inspired, encouraged, and strengthened in our everyday life. Here, the lure of the mallard is one of the great attractions. Travelers and tourists are very often highly amused by their antics, for example, a mother mallard doing her best to bring within bounds her mischievous but lovable little ducklings.

We very often see a nature lover intent on observing the precise flight formations of the mallards. In the field identification of birds, often the mallard is the first duck learned by beginners.

Large city parks are usually famous for their duck-feeding ponds where the mallard is usually the most numerous

visitor. These ponds are often the chief point of interest in the park, particularly for children.

And in the dead of night, when all is quiet, we are often thrilled by the winnowing wings of these mighty fliers, as they pass over us, steadily on and on.

PRELIMINARY STUDY

It is considered by the author that this life history and management study of the mallard is only a small part of a comprehensive nation-wide investigation which should be made. Although this investigation has dealt with the main factors necessary for the management of the mallard in western Montana, much more information is needed from many other aspects to make possible the perfection of a nation-wide restoration program which will result in the maintenance of a maximum and well-balanced population of mallards.

For example, practical suggestions from present findings and additional studies on botulism should be incorporated into the management program. More information relative to other diseases and to external and internal parasites would also be valuable as well as further data relative to the effect of grazing upon the cover and food supplies of the mallard. Factors that are responsible for fluctuations in population density must be studied, and a more thorough knowledge of winter populations of this species is needed. Do the same ducks remain in some localities the year round? Here the importance of extending banding operations is indicated.

Further information is needed concerning the kinds, varieties, and proportions of foods consumed by this species —information that must be obtained by analysis of stomach contents taken at different times of the year in the various habitats utilized by the mallard, not only in its nesting and rearing environments but also along its migration routes. The effects of natural enemies and other factors directly and indirectly related to mortality in the egg stage should be appraised on a nation-wide basis. Additional published information including the approach, methods, means, and results of some of the nation's major attempts to propagate mallards on its larger refuges would be very valuable. As continent-wide study continues, other problems needing investigation doubtless will be brought to light.

CONCLUSIONS

One of the chief conclusions substantiated by this study is the importance of whole-hearted and general cooperation between all agencies either directly or indirectly interested in the preservation of the mallard, as well as the need of the correlation of programs for privately-owned lands, communities, counties, and states. Further, our Federal government has realized that conscientious assistance among nations is necessary to give migratory waterfowl (among which the mallard is perhaps most important) the most favorable consideration. To that end, the United States has specific treaties with both Canada and Mexico.

In the final analysis, however, total maximum benefits to the mallard will result only if each state exerts effort to improve local conditions for the propagation and protection of this bird. It was learned in this study that definite

information is needed concerning the following habits, management practices, and characteristics to properly manage and encourage mallards in western Montana: migration, spring feeding cover, courtship and mating, honeymoon or rest period, nesting and egg laying activities, incubation, hatching periods, egg characteristics, predators, resting areas, plumages, family life, survival of young, relationship to certain other nesting species, year-around activities, food and food areas, grit, farming programs, winter feeding, and hunting activities.

An attempt has been made by the writer to set forth what he has been able to gather along these lines in western Montana in a concise manner, without the inclusion of a large amount of detail, some of which might be unrelated to the essential factors to be considered in making the study. It is hoped that the information included in this report will be valuable to interested game managers, hunters, nature lovers, farmers and businessmen.

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A SAMPLING TECHNIQUE FOR THE DETERMINATION OF HUNTERS' ACTIVITIES AND THE ECONOMICS THEREOF

Seth Gordon, Jr.

How much is a deer worth? How far does a hunter travel? How much money is spent? How many pheasants are killed? What is the landowner's position as a hunter? The answers to these and related questions are annually becoming more important to effective wildlife administration.

For satisfactory results the approach to these problems should be basically sound and adequately justified. This paper describes a sampling technique for collecting such factual material and applies it to Washtenaw County, Michigan. The method used is an original procedure which, it is believed, can be applied over larger areas.

Outline of the Method Used

In developing the sampling method in Washtenaw County only those data were used that are also available for larger areas. The method develops information on basic characteristics of hunters that can be classified under the three general headings of age, occupation, and income.

The first may be handled statistically for so small an area as a township, a city, or a village. The other two may best be considered on a state-wide basis or for groups of states having broadly similar characteristics. Information concerning hunter age and occupation were gleaned from individual license stubs and kill reports. Hunter income and other pertinent data were obtained by sufficient personal interviews to get a representative sample of the hunting population.

In sampling, the total hunting population is divided into age groups and each group is sampled in the proportion that it bears to the total hunting population. For example, if a first age group contains 50 hunters and a second 100, twice as many samples are taken in the group having 100 as in that having 50.

Justification for the use of a sampling method of this type is found in the widespread acceptance of such national polls as that of Dr. George Gallup and in the similar method used by the National Resources Board for determination of the characteristics of various population groups.

In Michigan, because of the method of issuing licenses and handling hunters' reports, age group sampling is insufficient. Ages appear only on the license stubs while occupational information is found only on the hunters' reports.

Because the information wanted in the survey is rather detailed and because the study was experimental, no method except personal interview was seriously considered. Field work was done during the summer of 1939, principally in the month of August. This was the period most available to the interviewer and it was considered desirable to learn whether hunters could recall experiences from the previous season at that time. If they could remember accurately, the use of existing personnel in Conservation Departments would be

facilitated because the summer period is ordinarily a slack time when these organizations could detail men to this work.

The area chosen was Washtenaw County, Michigan, principally because the University is located centrally in it and the opportunity for checking results during the winter was thereby facilitated. Additional considerations were that the county stands comparatively high as to the number of pheasants and rabbits killed and the relation between the farmer and hunter is fairly representative of rural areas adjacent to large cities. The 1935 Census of Agriculture shows that the County is about 89% farm land, with approximately half the total population resident in urban areas and an additional 25% in a rural though non-farming environment. The individuals questioned in this survey were all residents of the county and included not only licensees but also land owners who under Michigan law may hunt legally on the lands upon which they reside without purchasing a license. This group, referred to as "non-licensed," is kept separate in the summaries since so far as the author is able to determine from the literature, this is the first time that a comparison of licensed and non-licensed hunters has been made. The type of form used (Table 1) was based on general information gathered prior to the beginning of the survey.

EXPLANATION OF THE INTERVIEW FORM

Incomes.—The division into income groups was based on available data which indicated that the average rural income was approximately $350.00 and the average urban income about $750.00. For convenience, income groups were classified arbitrarily as: $0–500, $501–1,000, $1,001–1,500, $1,501–2,000, $2,001–3,000, $3,000+. Incomes of above $3,000.00 annually were relatively few and differentiation beyond this point was deemed unnecessary. It is realized that in dealing with farmers the annual cash income may not be the total income but it is considered satisfactory for the purposes of the study.

Ages and Occupations.—Ages were divided into groups exactly as they are recorded by the Bureau of Census. The classification of occupations follows that used by the Department of Conservation: professional, business, clerical, farm, skilled, unskilled, and "other." The last group by definition contains students, unemployed and retired individuals, and housewives. These divisions are more detailed than those generally used in economic studies but it was felt desirable that they be comparable to those employed by the Department of Conservation in order that correlation could be made with the official reports.

Tabulation.—The form was so devised that the data could be recorded by punching on code cards and tabulated by International business machines. A difficulty was that in its original form the blank provided space for 138 records which would require two cards since the standard code card contains only 88 spaces. In light of the material collected, it is now believed practical to arrange the information in such a manner that only one code card will be necessary; the revised form is shown in Table 7. At first the number of tabulation spaces was not considered a prob-

TABLE 1

Economic Survey
Washtenaw County, Michigan

No._____ Twnsp._____ Sec._____ Income Group (1) $0–500_____
(2) $501–1,000_____
Name_____ Occup._____ Age_____ (3) $1,001–1,500_____
(4) $1,501–2,000_____
(5) $2,001–3,000_____
(6) $3,001 +_____

Shotguns					Rifles				
Gauge	No.	Typ.	Mke.	Age	Calibre	No.	Typ.	Mke.	Age
12									
16									
20									
28									
410									

Hours hunted last season, total _____
For Farm game _____
For Migratory game _____
For Forest game (except large) _____
For Large game _____
For Non-game (crows, etc.) _____
Expended in Trapping _____

Distance traveled, total _____ miles
Driving own car _____
As passenger _____
Length longest trip _____
Number of trips _____
Number of meals _____
Number of nights' lodging _____
Other expenses $_____

GAME KILLED

Kind	*No.*	*Kind*	*No.*	*Kind*	*No.*
Pheasants		Opossum		Squirrel, Fox	
Ruffed Grouse		Skunk		Gray	
Prairie Chickens		Badger		Bear	
Sharp-tailed Grouse		Raccoon		Deer	
Woodcock		Mink			
Geese		Coyote			
Ducks		Wolf			
Shore Birds		Fox			
Cottontail Rabbits		Bobcat			
Snowshoe Hares		Weasel			

Hunting Dogs, No. _____

Type—Birddog _____
Hound _____
Spaniel _____
Retriever _____
Other _____

Member Hunting Club_____
Sportsman's Organ_____

Do you hunt every year? _____

Do you hunt mostly on private _____ or public_____ land? _____

lem because it was originally determined that the Washtenaw County sample should be hand-tabulated in order that the writer might become more familiar with the data as they were accumulated.

Firearms.—Detailed information concerning shotguns and rifles, with principal reference to type and make, was considered essential in order that the present value of each arm could be estimated. Value determinations were made on the basis of the original price of the arm less depreciation in proportion

to the number of years of use. The type, make, and age of shotguns were recorded on the questionnaire and reference later made to arms catalogs to determine the original selling price of the gun. Since no standard method of rating depreciation is in use, a method was devised for the study, based on the price of used firearms set by dealers in the county. Under it, each gun was considered to have depreciated 20% in the first year and to have a residual value in its 31st year of 10% of the original cost. The remaining 70% was distributed evenly over the intervening 30 years at the rate of 2.33% per year. In some cases it was impossible to determine the manufacturer because the gun carried only a trade name and in these cases the original price was estimated.

Investment Value.—Summation of the average values of the arms in each income group makes up the "total computed investment" of the study. This does not take into consideration the value of dogs nor of hunting clothes; in a majority of instances hunting clothes as separate entities do not exist. No standard was found that appeared satisfactory for computing the investment value of dogs and they are considered in the financial tabulation only as items of expense at the rate of $3.00 per month each to cover food and other upkeep.

Expense Items.—In computing the number of hours of hunting, five classes of effort were recognized. Mileage was divided into two classes: that expended while driving one's own car and that expended while riding as a passenger. In order to arrive at the average cruising radius the length of the longest trip was required. The number of times the individual went hunting (without reference to automobile mileage) appears separately. Since it was felt that the actual expenditure for meals and lodging could not be accurately determined, a standard valuation was assigned at the rate of $.50 per meal and $1.00 per night's lodging. The general term "other expenses" covers all cash expenditures except the items noted, including those for shells, guns, and dogs purchased during the current year, clothing and all expenses of hunting trips other than traveling, meals, lodging, and the upkeep of dogs. This item was made inclusive for simplicity and because it was felt that a combined estimate would be at least as accurate as any attempted itemization.

Game Kill.—Two squirrel species were included that were not legal game during the 1938 season.

Dog Ownership.—Hunting dogs were considered from two standpoints, as an expense item as noted above and also as an adjunct to hunting. Four major types of dogs are provided for and others referred to a miscellaneous group.

Other Items.—The three supplementary items at the end of the table were recorded as a matter of interest but it was felt that the relationships are not sufficiently important to be included in the summarized tabulations. There are two major types of affiliations with which sportsmen are concerned, namely hunting clubs (with buildings and properties) and sportsmen's organizations or similar meeting groups. The question regarding the regularity of hunting was invariably answered in the affirmative. Replies to the question as to distribution of hunting time on private and public lands were found to follow the type of license, that is, in general, small

game licensees hunted on private lands and big game hunters on public lands.

FIELD PROCEDURE

In order further to test the accuracy of the basic assumptions of the study, the field work was so designed that a random geographical sample would be obtained; this was accomplished by making use of the regular road spacing resulting from the rectangular survey system. After completing the survey on the most northerly road in the township, others were taken in order and the north or south roads were followed as appeared to be convenient. Ten of the twenty townships in the county were completely covered in this manner.

Stops were made at all places where men were seen in the vicinity of the road. If three or four houses were skipped, no occupants being visible, stops were made at the next few whether the occupants were apparently there or not. No effort was made to obtain interviews except with licensed hunters but all individuals who admitted to hunting were interviewed. In a number of instances, unlicensed hunters were reluctant to admit that they hunted during the previous season. However they were assured that approach to all individuals was made on the basis that this was an informational survey without relation to law enforcement and with no attempt to pry into the private affairs of anyone.

Supplementary information was obtained on the type of posting in each township by three main classes: (1) Where public hunting was not permitted, (2) where posted land was used for hunting under lease, and (3) where unposted lands were available for public hunting. Each type of land posting was recorded in color on the township plat map. This plotting served also as check upon the extent of coverage of the survey in each area. The township populations as reported in the 1930 census were used as a general guide respecting the number of individuals sampled, the more populous areas receiving greater attention. A random sampling method was also used in the villages and towns but stress was laid here only upon individuals known to be hunters, since the question of land holding did not seem pertinent.

It was felt that the accuracy of the information gathered was definitely affected both by the attitude of the interviewer and by the order in which the questions were asked. The income question was included as an experiment and with some trepidation. In practice, it was always asked at the end of the interview and if the interview happened to be conducted in a place where other individuals could overhear, the man was taken aside and merely asked to indicate into which group he fell. In this way, he was not subjected to embarrassment by being asked to give personal information audible to others present. It afforded some amusement to the interviewer to find that a number of people were curious about answers to this question that had been given by their friends. They were always told, however, that answers were considered to be personal information, and not subject to dissemination. There were only two individuals who flatly refused to furnish answers to the income question and only one who refused to answer all questions. In several cases, the putting of certain questions was inadvertently omitted.

Order of Questions.—So far as the order of asking the questions is concerned, it was felt that the best results were obtained by recording first the name, age, and occupation, and the type of license. Information concerning arms was then requested. At this point the order of the form was departed from to ask the number of trips taken in pursuit of game. In practice, it was found best to inquire as to the number of times the individual went pheasant hunting, a question readily answered because of the relative shortness of the pheasant season. Then the number of additional trips taken in the course of the rabbit season was entered. If big game hunting was indicated by appropriate license, the number of trips taken in pursuit of large game was set down. This was almost always identical with the number of days spent hunting such game. The length of the longest trip and then the approximate mileage were determined. These answers seemed relatively easy because the individuals associated the various trips made with the distance traveled; it was surprising how readily these estimations were forthcoming. Similarly, recollections as to the hours spent in pursuit of various classes of game appeared relatively easy. Recording was done on a basis of 8 hours per day, except for a few individuals who reported hunting big game for as long as 10 hours at a time. It is sufficiently accurate, however, to estimate days of big game hunting by dividing 8 into the total number of hours. Very few hunters of rabbits, pheasants, or migratory game birds reported hunting a full 8-hour day. The vast majority spent perhaps 6 hours as a maximum, usually making a number of short trips of 1 to 2 hours duration. Legal forest game during the 1938 season included the ruffed grouse, snowshoe hare, and some fur-bearing species. The item of time expenditure in pursuit of animals other than game is important not so much for the total number of hours reported but in revealing the number of individuals who made the expenditure. Trapping time seldom exceeded two hours per day and few trappers reported having lines out during the full trapping season.

The game kill was the next subject of question and by this time the trend of association was sufficiently established to make the results accurate The pheasant season limit of 6 birds operated rather firmly in a hunters' mind to fix the number killed. The few individuals who hunted grouse and migratory birds exhibited sufficient interest to convince the inquirer that their memory also was accurate within reasonable limits There may be some question about the precise number of rabbits killed because of the high season limit of 50 and because a number of individuals killed rabbits incidentally to pheasant hunting. The number of fur-bearing animals reported with the exception of opposums was subject to accurate recollection because the hides were sold. Record was made on each form of the average price received per pelt. Violations were considered to be of sufficient importance to record. In some cases these were openly admitted; in others where violations were suspected, such questions related to the pheasant kill as "All cocks?" or "Did you kill only six?", established the fact of law violation. No claim is made that the percentage of violations recorded is an accurate indication of the

total that may have occurred but it is an item of interest.

Accuracy of Answers.—On the whole, it is felt that answers were very satisfactory and that the results of inquiry in summer compared favorably with those from reports made promptly at the end of the hunting season. There is, it would seem, a limit to the period in which hunters are sufficiently interested in the previous season to want to discuss it. As the new season approaches, attention is focused on it and the old season is more or less forgotten. No difficulty from this cause was apparent, however, until the month preceding the new season.

This first study was considered not only as an experiment but also as a public relations job. Consequently when a hunter had time and apparently the desire to continue a conversation, the interviewer remained. Several of the talks lasted for an hour or more, but it is believed that the good-will and interest engendered were worth the time expended.

ANALYSIS OF RESULTS

The great extent of the material gathered renders impossible a detailed discussion of it in this paper, but summaries of the findings are presented to illustrate the methods used.

Incomes and Expenditures.—Computation of hunter expenditures as a whole depends to a large extent upon data not called for in the tabulation form, as, the average number of passengers per car, the place of lodging, and the place where meals were purchased. However, in checking the number of passengers, including the driver, generally carried on a hunting trip, a total of 5 was found to be rare, 4 fairly numerous, 2 numerous, and 1 rare, the majority reporting 3 per car. Costs of automobile operation are generally estimated at $.05 per mile but in order to simplify the computation and avoid fractional values, summaries for this survey were made on the basis of $.02 per passenger-mile or in view of the usual number of travelers a total of $.06 as the average car-mile operating cost.

Sample Expense Computation.—One-half of all the individuals interviewed were in the $0–500 income group. Based on the hunting population as a whole this would mean that approximately 300 individuals fall into this group. Fifty per cent of the individuals interviewed reported a mileage expenditure averaging 360 miles. If the travel habits of this part of the hunting population are similar to those of the sampled group, 50% or 150 of them would average about 360 miles each. Computed on the basis of $.02 per mile for each individual we reach $1,080.00 as the total travel expenses of the group.

The average of the "other expenses" item for the sampled group was $5.00, so total for the entire 300 was $1,500.00.

Thirteen per cent of the individuals interviewed, reported buying an average of 26 meals which are arbitrarily valued at $.50 each. Applying this ratio and unit cost to the 300 hunters gives $507.00 as the total cost of meals.

In the same manner, lodging cost reported by 4% or 12 individuals for an average of 9 nights' lodging each, valued again arbitrarily at $1.00 per night indicated $108.00 as the total lodging expenses.

Thirty per cent of the individuals interviewed reported owning a dog, hence a computed total of 117 dogs were

used by this income group. Expenses at the rate of $36.00 per year per dog amount to $4,212.00 as the total dog cost.

License fees were computed as follows: Small game licenses, 300 at $1.00 each; and big game licenses for 5 of the individuals at $2.25 each. Similarly trapping licenses for 15% of the individuals at $1.00 each amount to $48.00.

Direct expenditures are the sum of all these items:

$1,080.00	Total travel expenses				
1,500.00	"	other	"		
507.00	"	meal	"		
108.00	"	lodging	"		
4,212.00	"	dog	"		
300.00	"	small game license fees			
108.00	"	large	"	"	"
48.00	"	trapping		"	"
$7,863.00	Expenses $0–500 income group				

Investment in shotguns found to average $8.00 per individual indicates $2,400.00 as the total. If we assume that depreciation on this investment is at the rate of 3% per year, the annual depreciation charge equals $72.00 which must be added to the direct expenses, making a total of $7,935.00.

$7,863.00	Direct expenses as figured above
72.00	Annual depreciation on shotguns
$7,935.00	Total annual expense for the group

By division it is evident that the average annual expense of each hunter in the lowest income group for all items is $26.45.

The summary of the investment in guns and the annual expenses of all the income groups is given in the following tabulation:

TABLE 2

SUMMARY ANNUAL EXPENSE AND INVESTMENT

Income class	*Number of hunters*	*Direct expenditures*	*Investment in guns*
$0–500	300	$ 7,935	$2,400
$501–1,000	500	14,875	4,750
$1,001–1,500	300	12,219	3,700
$1,501–2,000	200	16,363	3,960
$2,001–3,000	150	10,605	2,600
$3,001+	45	4,346	2,990
Totals	1,495	$66,343	$20,410

This summary involves the assumption that the resident licensed hunters in the county spent at a rate equal to that of the individuals interviewed. The computed annual expenditure of approximately $66,000 for 1,500 individuals averages more than $40.00 for each licensed hunter in the county. The total investment in guns of about $20,000 is a figure that should remain relatively static from year to year unless hunting habits change considerably. The figures should be regarded as approximations substantiated by reasonable sampling but they should be used only tentatively until surveys of larger areas bear out the trends they show.

Summarization of Results of Hunting.—The results of hunting computed on the same sampling bases are summarized as follows:

Hours spent in hunting annually by resident licensed hunters	94,000
Pheasants killed annually by resident licensed hunters	3,900
Rabbits killed annually by resident licensed hunters	14,000
Deer killed annually by resident licensed hunters	490

Value of furs trapped by resident licensed trappers.....$15,400

Other items may be subject to summarization but it is felt that they were not sufficiently represented in the samples to merit such treatment. To arrive at the value of the furs trapped, record was made of the amount ordinarily received by typical trappers for various types of pelts. Throughout the county as a whole this averaged about $.90 per muskrat and $8.00 per mink, with other species running close to the general market value for pelts in 1938.

Characteristics of Various Age Groups.—The number of males of hunting age of Washtenaw County and the proportion of each age class which purchase hunting licenses is shown graphically in Figure 1.

It is clear that the largest class in the population, ages 35–44, buys the largest number of licenses. This was found to be true also in 10 representative counties in Pennsylvania. The remaining age classes however, do not purchase licenses in proportion to the total number of individuals included, a preponderance of licensees falling in the younger groups.

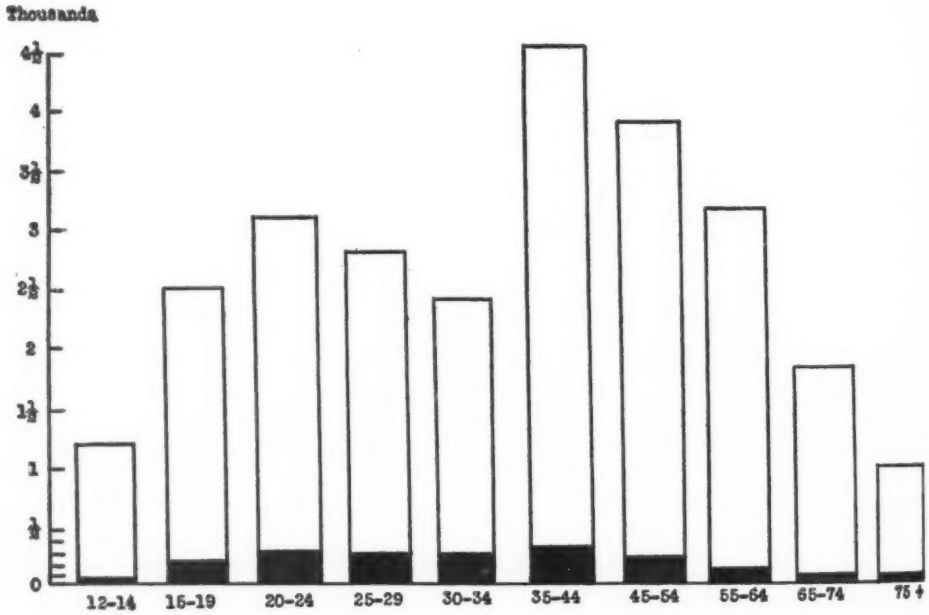

FIG. 1. Number of males of hunting age in Washtenaw County. (Black areas represent number in each group purchasing small game licenses.)

The number of licenses issued is shown in Table 3.

The bottom line shows the percentage of each class interviewed in the survey. This may be compared with the percentage of all hunters in that age class to indicate the degree of completeness of the study.

Graphic comparison of selected items believed to be characteristic of the groups as a whole are given in Figures 2–4.

It will be noted that with the exception of the first and last groups for which the number of individuals in the sample was low, the number of trips taken annually averages around 15. The average time expenditure per trip was in the neighborhood of 2 hours. Hunting success measured by the average number of pheasants and rabbits bagged annually is shown in the following two graphs (Figures 3 and 4).

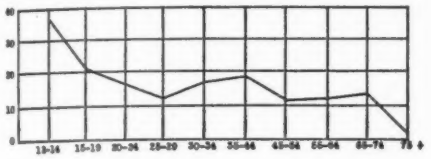

FIG. 2. Average number of trips taken during the 1938 season by hunters in the various age classes.

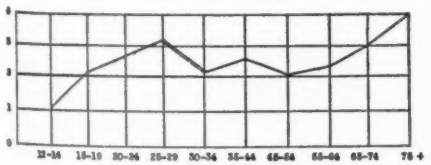

FIG. 3. Average annual pheasant kill per hunter by age classes.

Here again the approach to uniformity is remarkable. On the basis of the computed kill of pheasants, for example, an average for all age classes of 2.6 pheasants per hunter for the 1938 season is demonstrated. The Conservation Department, from a 20% sample of all license reports, computed that approximately 1,600 hunters both county and non-county residents averaged 2.8 pheasants per man during this season. The graph showing the average number of rabbits bagged annually per hunter again exhibits a considerable degree of uniformity. The average kill for all age groups of 9.3 rabbits per individual may be compared with the Conservation Department's estimate that 8.1 per hunter were bagged, based on the reports of 1,700 hunters without regard to residence in the county. The numbers of hunters in the sample reporting kills of pheasants and rabbits are about equal despite the fact that almost four times as many rabbits as pheasants were killed.

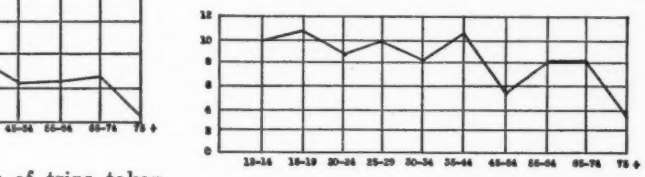

FIG. 4. Average annual rabbit kill per hunter by age classes.

TABLE 3

SMALL GAME LICENSES ISSUED

Age Class	*12–14*	*15–19*	*20–24*	*25–29*	*30–34*	*35–44*	*45–54*	*55–64*	*65–74*	*75+*
Number of hunters in county	32	192	249	225	226	251	189	125	50	9
Percentage in the sample	1	10	10	17	17	10	22	6	6	.005
Percentage in the class	2	12.5	16	15	15	16	12	8	3	.006

Computation of total kills using the method previously described for other items results as follows:

TABLE 4

SUMMARY OF REPRESENTATIVE TAKE OF ANIMALS BY AGE CLASSES

Age group	*Pheasants*	*Rabbits*	*Muskrats*
12–14	32	320	670
15–19	303	2,035	684
20–24	650	2,125	4,200
25–29	675	2,250	3,564
30–34	497	1,831	5,760
35–44	653	2,635	3,484
45–54	416	1,021	2,068
55–64	300	1,125	1,200
65–74	150	425	880
75+	36	36	0
Totals	3,712	13,803	22,410

These totals compared to those computed for income groups are almost the same for rabbits but show 200 less pheasants; the latter result, however, is identical with that reached in the computation of the kill by occupational groups (Table 5). This small difference in the results reached by different methods of approach are not thought to be significant and the approximation that between 3,700 and 3,900 birds were killed by resident licensed hunters in the County in 1938 is believed to be sufficiently accurate for all practical purposes.

TABLE 5

SUMMARY OF REPRESENTATIVE TAKE OF ANIMALS BY OCCUPATIONAL GROUPS

Occupational groups	*Pheasants*	*Rabbits*	*Deer*
Professional	150	600	20
Business	315	640	40
Clerk	315	810	45
Farm	1,150	4,650	150
Skilled	700	1,950	75
Unskilled	790	3,150	150
Other	324	1,080	40
Totals	3,734	12,880	520

Characteristics of Various Occupational Groups.—The number of times individuals in the various occupational classes went hunting is shown graphically in Figure 5.

FIG. 5. Average annual number of trips per person in each occupation.

Here again the uniformity is noteworthy, all classes averaging between 15 and 20 trips during the season. Results as to the average number of pheasants and rabbits bagged annually are shown in the following two graphs (Figures 6, 7). The no-license group included in Figures 5–7 is shown not as an occupational class but as one for which very little information has previously been available.

FIG. 6. Average annual pheasant kill per hunter by occupation.

FIG. 7. Average annual rabbit kill per hunter by occupation.

It should be noted that although computed success is highest among the clerical group so far as the number of

pheasants is concerned, there were only 15 individuals reporting in this class. Similarly, although the professional group appears to have accounted for a high average number of rabbits per person, this class was represented by only 10 individuals. The two laboring groups and the farm class include the largest numbers of individuals and their average success is relatively high. This means, of course, that the farmers and wage-earners get a large proportion of the game bagged. It can be seen from Table 5 that the laboring groups killed approximately 5,000 of the 13,000 rabbits and that the farmers killed almost as many more. The bag of these three classes together is almost 70% of the total rabbit kill. About the same proportion holds also in the number of pheasants bagged.

Non-licensed Group.—In order to determine the proportion of this group in the population, a record was made of all farmers questioned in the course of the survey, as to whether they did or did not hunt. In this count, 236 farmers reported and of these, 144 were hunters while 92 were not, a relative distribution of 60%:40%. Of the 144 hunters approximately 50% hunted legally on their own lands without purchasing a license. In order to determine the total number of unlicensed individuals in the County, reference was made to figures for rural farm populations in the 1930 Census. The average bag of the sampled hunters was then applied to that portion of the population computed to be hunters on the basis of the count made in the course of the survey. Divided into age groups, the numbers of unlicensed hunters in the population and in the sample appear in Table 6.

TABLE 6
RURAL FARM POPULATION (1930)

Age group	*Number*	*Percentage in sample*	*Percentage in population*
12–14	480	5	8
15–19	700	28	13
20–24	450	12	8
25–29	350	5	6
30–34	400	1	7
35–44	1,000	5	19
45–54	900	22	16
55–64	700	15	13
65–74	400	5	7
75+	150	1	3
Total	5,530		

It will be noted that the percentages included in the sample are far from uniform for the various groups. However, the hunting experiences reported by the 81 hunters in the sample were so uniform that it is believed that the computation is fairly accurate. In order to avoid exaggeration, the calculation was based upon 50% of the individuals although the results of the survey indicated that about 60% actually hunted. If half of them hunted, 2,765 would be the total number hunting and of these, about 1,900 would be unlicensed.

If these unlicensed individuals experienced hunting success similar to that of the sampled groups they may be computed to have bagged the following numbers of certain animals: Pheasants 1,660; Rabbits 1,550; Muskrats 5,500. As stated before, the author has not been able to find any previous discussion of this group in comparison with licensed hunters. The fact that they bag approximately 40% as many pheasants, for instance, as all the licensed hunters is considered to be of no little significance to game management.

USES OF THE SURVEY MATERIAL

The findings of the survey have been so consistent as to indicate that they

are accurate. It is intended, however, to subject the method to statistical analysis in a future paper when a larger series of returns from a wider geographical area are available.

On the basis of the data presented, the following possibilities are evident. These ideas are not held to be either complete in themselves or to be exhaustive.

Land Management Programs.—Indications are that we are closely approaching a period when master planning for wildlife will attain increasing importance. This means that we will gradually minimize such things as artificial restocking or law enforcement as objects of prime consideration in wildlife management and give increasing attention to biological, economic, sociological, and political techniques that may be applicable to the science of wildlife management. We should, therefore, learn the attitudes and attributes of the hunting population. Administration of wildlife in the past decade has evidenced an increasing awareness of the importance of farm game and farm game hunting. To what degree this aspect should be emphasized is a proper subject for determination by surveys such as the one here described.

Information can be presented in considerable detail for each group in the three main classes, ages, occupations, and incomes, and on subjects not touched upon in this general account of the survey. For instance, reference to the occupational class tables (not here reproduced) shows a difference between the average number of trips taken for small, and for big, game. Computation of the average hour expenditure in hunting the classes of game is thereby facilitated. For example, the farm occupational group averaged 16 trips computed on the basis of the hours expended for farm game alone, which would indicate that slightly less than 2 hours is the average duration of each trip for farm game hunting. Similar computations are possible for mileage, yield of game per hour per mile, etc. Administratively, information derived in this manner can be used as a basis for the selection of management or purchase areas.

Gun Pressure Computations.—Information on the number of hours necessary to bag a pheasant has achieved popularity as an index of abundance of the birds and of gun pressure upon them on various areas. Without entering into the merits of this use of the data, it may be noted that they are available from the figures gathered in the survey. For example, in the farm occupational group the average farm-game time expenditure is 30 hours per hunter annually while the average pheasant kill for the same period is 2.5 birds or 1 pheasant for every 12 hours. Considering only those who actually bagged pheasants (70% of the total number of hunters), the average pheasant kill represents a time expenditure of 9 hours. Similar computations can be made for all of the classes of hunters and game.

Budget Justifications.—Budget justification for a variety of expenditures is becoming increasingly important, particularly in the states with large hunting populations. Present information that may be used in this connection is restricted mostly to the amount of game killed, and may not provide sufficient basis for decisions among competing items of expenditure. In Washtenaw County, if the number of individuals re-

porting kills of several game species is any criterion, almost as many individuals hunt and kill pheasants as report hunting and killing rabbits. We usually assume that rabbit hunters are more numerous than those who hunt birds. The basis for a fair estimate of the actual activities is here contained and upon it could be based justification for restocking or intensive management of those species proved to be important to the hunters.

Valuation.—If estimates of values are desired, the fundamental figures upon which they may be made are included in the summary data. No effort has been made to fix a value for recreational hours; it could be done arbitrarily or it could be achieved by dividing the average expenditures by the average number of hours on the theory that recreation is worth what the individual is willing to spend for it. There is considerable apparent merit in applying this principle but the computations should be correlated with the respective incomes of the individuals. It is obvious that the total expenditures of all individuals or the average expenditure for any group may be computed from the facts gathered by the survey.

Game Kill.—There is some question as to the accuracy of the game kill reported by hunters to conservation departments. Reports may be modified from two motives: First, to minimize the kill in an endeavor to convince conservation officials that there was a dearth of game and second, to magnify the kill to convince the officials that game has been shot out and should be replenished. In very few cases do reports show kills in excess of bag limits or any other violation of hunting restrictions. There is also apparent reluctance to submit a report when the hunter has bagged no game. The method outlined overcomes these difficulties at least in part. Of great but hitherto unrecognized importance in relation to the total game kill are the unlicensed hunters who are not required to submit reports of their activities. That these individuals may take a large amount of game is indicated by the results of this summary. Without taking this factor into account, the best laid management plan might fail. It seems that estimation of the game kill could be based upon age class sampling after the fundamental characteristics of each age class are known. This would eliminate the present inaccuracy of assuming that the reports submitted accurately reflect the activities of the hunters as a whole. It also seems that adopting a sampling system might eliminate the difficulties of getting an adequate number of returns with a consequent great saving in costs.

It also appears from this survey that the game kill estimates of the Department of Conservation in Michigan may be high, although the average bag per hunter may be correct. For example, the Department received reports after the 1938 season from about 1,600 hunters who reported bagging approximately 8,200 pheasants in Washtenaw County, including both residents and non-residents. These reports were received in the first 100,000 cards tabulated by the Department for the 1938 season. Since 100,000 reports represented 19.4% of the total licenses sold, it was computed that there were 8,200 pheasant hunters in Washtenaw County. The 1,600 who actually reported, acknowledged killing 4,500 birds. From this it was esti-

mated that 23,300 pheasants were killed in the county during the season, not allowing for crippling losses. Since the fall sex ratio of these birds is reliably reported to be 1:1, the estimate cited would imply a total population of 46,600 if all the birds killed were cocks. In the 20 townships of Washtenaw County there are 720 sections or square miles. As pheasant range this must be reduced by at least 20 square miles by eliminating water areas and roads and urban holdings where no hunting is possible and posted areas where no hunting is permitted. The approximately 47,000 birds estimated would, therefore, represent a fall population (for 700 sections) of at least 67 birds per section, doubtless too high, as reliable observers estimate it to average nearer 40. Of these 20 should on the average be cocks. If the improbably high proportion of 18 of these cocks was killed on each of the 700 sections, the total possible kill would have been in the neighborhood of 11,600, not 23,000. According to computations of this survey, approximately 6,000 birds were killed by resident licensed and non-licensed hunters leaving 5,600 birds as the take of hunters not residing in the county. It may be that this method of handling such computations is subject to correction but doubt also is thrown on the prevailing methods, and the desirability of correlation of a survey of this type with other essential game management information to obtain dependable administrative guidance is made clear.

Law Violation and Enforcement.—As an aid to law enforcement, the type of survey described is useful in the following ways: It gives an opportunity to discuss with landowners the difficulties that they may have with uncooperative hunters, and also to talk with the hunters and evaluate their attitudes; again, the measure of the probable violations can be checked against enforcement records.

SUGGESTIONS REGARDING FUTURE SURVEYS

State-wide Application.—In the author's opinion, only through making similar surveys on larger areas can we achieve full appreciation of the inherent possibilities of the sampling method. Standing alone, the Washtenaw County survey although interesting is limited in application. It is believed that guided by the experience of administrators and by information relative to hunters already available, it is possible to select and survey a few typical counties within a state and obtain information there that can be applied on a state-wide basis. From experience in the present study. it would seem that existing field forces of the Conservation Departments could be quickly trained to gather accurate data and that they could complete the surveys without too much diversion from their regular duties.

Public Relations Value.—Interviewing hunters on a friendly basis is valuable from a public relations standpoint and gives the interviewer not only an opportunity to gather the information especially sought but also to become informed about other topics such as the type and extent of land posted, pheasant nesting losses, and so on. Surveys conducted periodically would serve to reveal hunting trends and to indicate desirable revisions of state game policy.

Periods Suggested.—It is suggested,

since the ultimate computations must be somewhat closely related to federal statistical information, that an appropriate time for a survey would be either soon after the decennial federal census or after the agricultural census that is taken every five years.

Cost of Survey.—In the interest of economy in tabulation, revision of the form used in the present survey is suggested; a revised schedule is presented in Table 7. This survey cost only about $250.00, making the rate for field work for each report collected about 60 cents. This is too expensive for routine use but is justified for this experimental work. Coverage for a rural area after the interviewer has gained experience should proceed at the rate of about one township per day and should result on the average in about 20 completed interviews. This will represent about 100 miles of travel per day, depending to a large extent upon the distance the interviewer must go from his base of operation. In urban areas, it should be possible to obtain 50 interviews a day with a negligible travel expense. The urban interviews can profitably be conducted during evening hours wherever a concentration of hunters may be found.

Tabulation Cost.—The cost of summarizing the results will depend to a great extent upon the method of tabulation. The form as revised (Table 7) is amenable to tabulation by the International Business Machine code.

TABLE 7

SUGGESTED REVISED FORM

Co._____ Twnsp._____ Occup._____ Monthly Income_____ Age _____
No license_____ Small Game_____ Large Game_____ Trapping_____

Shotguns					Rifles				
Gauge	No.	Type	Mke.	Age	Calibre	No.	Type	Mke.	Age

	Hours	Trips		
Hunted last season, total	_____		Distance traveled, total	_____ miles
For Farm game	_____		Length longest trip	_____ miles
For Migratory game	_____		Number of meals	_____
For Forest game (except large)	_____		Number of nights' lodging	_____
For Large game	_____		Expenses other than items above	_____
For Non-game (crows, etc.)	_____			
Expended in Trapping	_____			

Game Killed

Kind.	*No.*	*Kind*	*No.*	*Kind*	*No.*
Pheasants	_____	Snowshoe Hares	_____	Wolf	_____
Ruffed Grouse	_____	Squirrel, Fox	_____	Fox	_____
Prairie Chickens	_____	Squirrel, Gray	_____	Bobcat	_____
Sharp-tailed Grouse	_____	Opossum	_____	Weasel	_____
Woodcock	_____	Skunk	_____	Muskrats	_____
Geese	_____	Badger	_____	Bear	_____
Ducks	_____	Raccoon	_____	Deer	_____
Shore Birds	_____	Mink	_____		
Cottontail Rabbits	_____	Coyote	_____		

Hound _____	Retriever _____	Member Hunting Club _____
Birddog _____	Other types _____	Member Sportsman's Organization _____
Spaniel _____		

Punching the cards and summarizing them should cost in the neighborhood of $50.00 per thousand.

SUMMARY

1. This paper reports a method of sampling hunter activity according to age, income, and occupational groups, that was carried on experimentally in Washtenaw County, Michigan.

2. Field work was done in the summer of 1939, that season being selected partly to measure the ability of hunters to recall experiences of the previous open season.

3. The survey covered 10 of the 20 townships in the County and gathered statistics on some 300 licensed and non-licensed hunters resident in the County who hunted during the 1938 season.

4. Each individual was interviewed personally and his replies entered on a questionnaire form.

5. The order in which the questions were asked was found to be an important factor in inducing correct responses.

6. Cooperation in supplying information was uniformly excellent.

7. It is believed that the accuracy of the replies is equal to any hitherto obtained in this field.

8. The results of the survey were computed according to the proportion that the particular group involved bore to the total number of individuals in the sample and consequently to the state population.

9. The entire series of replies exhibited a consistency that is believed to be beyond the working of chance.

10. It is computed that the resident licensed hunters in Washtenaw County expended approximately $66,000 during the 1938 season, had an annual investment in guns of approximately $20,000, and trapped furs valued in the neighborhood of $15,000. Their hunting and trapping time expenditure is estimated at 94,000 hours. It is computed that 3,900 pheasants and 14,000 rabbits were bagged.

11. The survey findings are believed to be useful for administrative and game management purposes in a number of ways, a few of which are described.

12. Work of this type has certain advantages that make it worth further trial on larger areas.

13. It is believed that by sampling a few representative counties, accurate information applicable to entire states can be obtained.

14. The cost of the experimental survey for field work alone was approximately $.60 for each completed interview. With experience, it is believed that costs of further surveys might be considerably reduced.

15. A suggested revision for the interview is made to achieve economy without reduction in accuracy.

ACKNOWLEDGMENTS

In the course of this work many people have given helpful advice and encouragement. To them, I should like to express my appreciation and gratitude. Among these should be included my father and Richard Gerstell of the Pennsylvania Game Commission and H. D. Ruhl of the Michigan Department of Conservation. The financial help extended by the School of Forestry and Conservation of the University of Michigan and the Game Division of the Michigan Department of Conservation

made it possible to pursue the field work pertaining to this study. To those members of the Faculty who have given freely of their time and lent direction to these efforts many thanks are due. Of these, Dean S. T. Dana and Professors H. M. Wight, S. A. Graham, and E. C. O'Roke should be given special mention. Last but not least all of the people who so kindly cooperated in the interviews deserve credit for making the study possible.

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A STUDY OF THE FALL FOOD SUPPLY OF THE RING-NECKED PHEASANT AND THE BOB-WHITE QUAIL IN WASHINGTON COUNTY, RHODE ISLAND[1]

Thomas Wright, Jr.

This study was begun in the fall of 1937 and continued through 1938 and 1939, with the purpose of determining the foods eaten by the ring-necked pheasant and the bob-white quail, as well as the chemical composition of the plant items taken.

In Rhode Island, except in a few sections, the bob-white, for several years, has not yielded a surplus which could be safely harvested by hunting and it is believed that the basic stock is dangerously depleted. The ring-necked pheasant, although remarkedly prolific in many parts of the United States, has here failed to produce a population large enough for good shooting despite the fact that during the last ten years more than 20,000 of the birds have been liberated.

No research has ever been undertaken in Rhode Island on any phase of the life cycles of these birds. Many factors may be involved as causes of the low populations but it was thought that a deficiency of staple foods might be limiting. For that reason this investigation was undertaken and it was believed that the knowledge gained would be of some use in guiding wildlife management in the State.

Introduction of Pheasants into Rhode Island

Horace Bloodgood in 1894 brought pheasants to his Anawam Farm at Boston Neck for the first known introduction into Rhode Island. Several other plantings by individuals were also made but not until the Commissioners of Birds began stocking as a State project in 1929 did pheasants become at all plentiful.

Review of Literature

Several food-habit studies of pheasants have been made in the United States. The earlier investigations, for the most part, sought to determine the economic status of the birds in relation to agriculture. Some of the later researches were in aid of management programs for increasing the species.

Swenk (22), in 1930 found the diet of 100 central Nebraska pheasants to consist of 76 per cent cultivated grains of which 67 per cent was corn. In Ohio, Hicks (14) reported that 55 per cent of the food taken by 52 birds of this species was corn. Cultivated grains formed 74 per cent of the subsistence of 352 ringnecks examined by Dalke (5) in Michigan; corn and wheat were predominant, composing 33, and 20, per cent, respectively. Bennett and English (1) in Pennsylvania learned that 74 per cent of the fall regimen of 423 pheasants consisted of corn and the seeds of associated weeds. In Minnesota, Fried (9) reported cultivated

[1] A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at Rhode Island State College, 1940.

grains to make up 81.3 per cent of the food of 515 of these birds.

Other searches also have revealed high consumption of cultivated grains although not expressing it on a percentage basis. It is apparent, in the States studied, that the pheasant is essentially a granivorous bird, about 75 per cent of its food consisting of cultivated grains.

Judd (16) reported the contents of 918 bob-white stomachs taken in many states to consist of 52.83 per cent weed seeds, 17.38 per cent grains, 9.57 per cent fruits and berries, 3.81 per cent miscellaneous vegetable food, and 16.41 per cent animal matter. Hicks (13), in Ohio, and Bennett and English (1), in Pennsylvania, reached similiar results for bob-whites examined in their states.

Errington (7) experimented on the nutritive values of winter game foods of pheasant and quail, feeding confined birds with the item to be tested and checking their weight curves against those of birds kept on a balanced ration.

THE INVESTIGATION

Description of Area.—Washington County is the southernmost county of the State and has an area of 332.5 square miles. It is bordered on the east by Narragansett Bay, on the south by the Atlantic Ocean, on the west by the State of Connecticut, and on the north by Kent County. The western part is chiefly hilly and forested, with only a few scattered farms, while the eastern and southern divisions are relatively level with considerable farm land for a distance of from three to six miles from the coast. A detailed land-use study by Gilbert (11) showed that 69.5 per cent of the total acreage was forested, 3 per cent cultivated, 14.6 per cent in grassland, and 12.9 per cent in miscellaneous uses.

Method of Procedure for Food Habits.—Examination of a great number of digestive tracts of these birds would be required for thorough understanding of their food habits, but such an extensive study would be impractical because of the scarcity of the birds in Washington County. It was believed, however, that a limited number of analyses would sufficiently indicate the diet of the pheasants for the season of study.

The crops of pheasants and quail were obtained from hunters in November and December. Each crop was given a number and the contents removed. The contents were then carefully sorted into the constituents which were counted and identified. When an item was not readily identified, it was placed aside and later referred to either the Botany or Agronomy Department at the Rhode Island State College, or to the United States Bureau of Biological Survey.

The percentages of the foods were computed by a modification of the dry-weight method. This method consisted of taking a known number of seeds, usually 500, drying them in an electric oven at 100°C., weighing them on a chainomatic balance, and then computing the average weight of one seed. If the total number of a given seed found in the study was less than 500, all were dried and weighed. The weights of all seed fragments and vegetative parts, as leaves, also were obtained. The total weight of all food items was them computed and the percentage by weight of each item determined.

Method of Procedure for Chemical Analysis.—Samples representing the

species of plants indicated as most important by the food-habit study were collected in October, November, and December. Seeds, berries, and nuts were taken from vigorously growing plants in various types of environment and, when possible, a pint jar was filled, the purpose being to collect a representative sample. Each was dried in an electric oven at 100°C. for five hours, then allowed to take up moisture as available in the laboratory air. In this way each contained about the same proportion of water that might be found

TABLE 1

FALL FOODS OF THE RING-NECKED PHEASANT IN WASHINGTON COUNTY, RHODE ISLAND, BASED ON THE EXAMINATION OF 32 CROPS AND LISTED IN THE ORDER OF THEIR PERCENTILE FREQUENCY OF OCCURRENCE

Scientific Name	*Common Name*	*Times Occurring*	*Frequency of Occurrence*
	Vegetable Matter		
Myrica carolinensis	Bayberry	16	50.00
Unidentified	Leaves and grass	15	46.88
Zea mays	Corn	10	31.25
Symplocarpus foetidus	Skunk cabbage	8	25.00
Rosa	Rose	7	21.88
Prunus serotina	Cherry	7	21.88
Unidentified	Tubers	6	18.75
Impatiens biflora	Snapweed	6	18.75
Vitis	Grape	4	12.50
Viburnum dentatum	Arrowwood	3	9.38
Solanum dulcamara	Nightshade	3	9.38
Alnus incana	Speckled alder	3	9.38
Ambrosia artemisiifolia	Ragweed	3	9.38
Polygonum scandens	False climbing buckwheat	3	9.38
Setaria glauca	Foxtail	3	9.38
Triticum aestivum	Wheat	2	6.25
Raphanus raphanistrum	Wild radish	2	6.25
Asclepias	Milkweed	2	6.25
Polygonum	Knotweed	2	6.25
Unidentified	Seeds	2	6.25
Quercus	Acorns	1	3.13
Secale cereale	Rye	1	3.13
Echinochloa crusgalli	Barnyard grass	1	3.13
Panicum miliaceum	Early fortune millet	1	3.13
Rhus toxicodendron	Poison ivy	1	3.13
Smilax	Bullbriar	1	3.13
Lathyrus maritimus	Beach pea	1	3.13
Avena sativa	Oats	1	3.13
Nyssa sylvatica	Black gum	1	3.13
Plantago lanceolata	Buckhorn plantain	1	3.13
Rumex	Curled dock	1	3.13
Malus	Apple	1	3.13
Fagopyrum esculentum	Buckwheat	1	3.13
Neslia paniculata	Ball mustard	1	3.13
Panicum capillare	Tickle grass	1	3.13
	Animal Matter		
Locustidae	Grasshopper	4	12.50
Bibio sp. and Ludius sp.	Larvae of Marchfly and click beetle	3	9.38
Gryllidae	Cricket	2	6.25
Coleoptera	Beetle	2	6.25
Formicidae	Ant	1	3.13
Lepidoptera	Caterpillar	1	3.13
Araneida	Spider	1	3.13
Hemiptera	Bug	1	3.13
Pulmonata	Snail	1	3.13

under the most favorable drying conditions out of doors. This amount was used in computing the percentage of water in the final analysis. The great variations in moisture exhibited by specimens taken under different conditions may be illustrated by a collection of grapes that was made while the fruits were fresh, containing 85 per cent moisture, compared to another slightly dried that had a moisture content of only 38 per cent. Such deviations would handicap analysis, hence the minimum moisture method was adopted and all samples reduced to a standard basis. After drying, the collection was quartered and one portion of it was ground in a Wiley mill fine enough to pass a one-millimeter sieve. Chemical determinations were made of crude protein, crude fat, crude fiber, ash, water, and nitrogen-free extract. The methods of the Association of Official Agricultural Chemists were used in all determinations. In Table 5 the carbohydrates include the crude fiber and nitrogen-free extract. The crude fiber represents the indigestible, and the nitrogen-free extract the digestible, carbohydrates.

RESULTS

Frequency of Occurrence of Food Items.—Table 1 shows the frequency of occurrence of the 44 different items found in the 32 pheasant crops examined. Vegetable matter occurred in all of the crops (frequency, 100 per cent), while animal matter was in seven crops (frequency, 21.9 per cent). Bayberries (*Myrica carolinensis*) were found in 50 per cent of the crops and led the individual items; grass blades and other green leaves were a close second, having a frequency of 46.9 per cent. Corn (*Zea mays*), fruits of skunk cabbage (*Symplocarpus foetidus*), rose hips (*Rosa* spp.), and cherry stones (*Prunus serotina*) each were found in more than 20 per cent of the crops. Unidentified tubers, seeds of snapweed (*Impatiens biflora*), and grapes (*Vitis* spp.) were the only other items with more than 10 per cent frequency of occurrence. Grasshoppers found in four crops were the leading item of animal matter as to frequency. Other items occurred in less than 10 per cent of the crops examined.

Similar information for the 50 different food items found in 69 quail crops is shown in Table 2. As with the pheasants, vegetable matter was found in all crops. Ragweed (*Ambrosia artemisiifolia*), bayberry (*Myrica carolinensis*), and snapweed (*Impatiens biflora*) were the items of most frequent occurrence with percentages of more than 40 per cent each. Following these corn (*Zea mays*), skunk cabbage (*Symplocarpus foetidus*), yellow foxtail (*Setaria glauca*), false climbing buckwheat (*Polygonum scandens*), poison ivy (*Rhus toxicodendron*), Ladysthumb (*Polygonum persicaria*), arrowwood (*Viburnum dentatum*), and lambsquarters (*Chenopodium album*), ranging between 20.3 per cent and 10.2 per cent, were the plants most frequently represented. Animal matter occurred twenty-six times (frequency 37.7 per cent). Beetles, spiders, and grasshoppers led the list, which included also crickets, bugs, ants, snails, and hornets.

Percentages by Weight of Food Items (Pheasant).—On the basis of percentages by weight, the food from the 32 pheasant crops examined consisted of 96.62 per cent of vegetable, and 3.38 per cent of animal, matter (Table 3). On a weight basis, cultivated grains

TABLE 2

FALL FOODS OF THE BOB-WHITE IN WASHINGTON COUNTY, RHODE ISLAND, BASED ON THE EXAMINATION OF 69 CROPS AND LISTED IN THE ORDER OF THEIR PERCENTILE FREQUENCY OF OCCURRENCE

Scientific Name	*Common Name*	*Times Occurring*	*Frequency of Occurrence*
	Vegetable Matter		
Ambrosia artemisiifolia	Ragweed	36	52.2
Myrica carolinensis	Bayberry	34	49.3
Impatiens biflora	Snapweed	29	42.0
Zea mays	Corn	14	20.3
Symplocarpus foetidus	Skunk cabbage	13	18.8
Setaria glauca	Foxtail	13	18.8
Polygonum scandens	False climbing buckwheat	12	17.4
Rhus toxicodendron	Poison ivy	12	17.4
Polygonum persicaria	Ladysthumb	9	13.0
Viburnum dentatum	Arrowwood	8	11.6
Chenopodium album	Lambsquarters	7	10.2
Polygonum pennsylvanicum	Smartweed	6	8.7
Sassafras variifolium	Sassafras	6	8.7
Rosa	Rose	6	8.7
Raphanus raphanistrum	Wild radish	5	7.2
Neslia paniculata	Ball mustard	5	7.2
Greens	Leaves (several species)	5	7.2
Malus	Apple	5	7.2
Avena sativa	Oats	4	5.8
Polygonum	Knotweed	4	5.8
Vitis	Grape	3	4.4
Phaseolus vulgaris	Bean	2	2.9
Panicum capillare	Tickle grass	2	2.9
Quercus	Acorn	2	2.9
Stellaria media	Chickweed	2	2.9
Echinochloa crusgalli	Barnyard grass	2	2.9
Nyssa sylvatica	Black gum	2	2.9
Prunus serotina	Cherry	2	2.9
Unidentified	Seed	2	3.0
Arisaema triphyllum	Jack-in-the-pulpit	1	1.5
Fagopyrum esculentum	Buckwheat	1	1.5
Chenopodium	Pigweed	1	1.5
Rumex	Curled dock	1	1.5
Triticum aestivum	Wheat	1	1.5
Pisum arvense	Pea	1	1.5
Alnus incana	Alder	1	1.5
Asclepias	Milkweed	1	1.5
Rhus copallina	Sumac	1	1.5
Lathyrus maritimus	Beach pea	1	1.5
Juniperus	Juniper	1	1.5
Unidentified	Lichen	1	1.5
Unidentified	Bud	1	1.5
	Animal Matter		
Coleoptera	Beetle	12	17.4
Araneida	Spider	12	17.4
Locustidae	Grasshopper	11	15.9
Gryllidae	Cricket	8	11.6
Hemiptera	Bug	4	5.8
Formicidae	Ant	2	2.9
Pulmonata	Snail	2	2.9
Hymenoptera	Wasp	1	1.5

formed 36.85 per cent of the total food, corn with 34.54 per cent predominating. Bayberries (21.04 per cent) were the largest item derived from woody plants, and fruits of arrowwood were second with 12.81 per cent. Food produced by

TABLE 3

FALL FOODS OF THE RING-NECKED PHEASANT IN WASHINGTON COUNTY, RHODE ISLAND, BASED ON THE EXAMINATION OF 32 CROPS AND LISTED IN THE ORDER OF THEIR PERCENTAGES BY DRY WEIGHT

Scientific Name	*Common Name*	*Per Cent*
	Vegetable Matter	
Zea mays	Corn	34.839
Myrica carolinensis	Bayberry	21.039
Symplocarpus foetidus	Skunk cabbage	13.361
Viburnum dentatum	Arrowwood	12.809
Rosa	Rose	5.128
Unidentified	Tubers	2.405
Triticum aestivum	Wheat	1.141
Quercus	Acorn	.939
Prunus serotina	Cherry	.808
Secale cereale	Rye	.755
Impatiens biflora	Snapweed	.650
Alnus incana	Alder catkins	.577
Vitis	Grape	.314
Greens	Leaves and grass	.299
Solanum dulcamara	Nightshade	.253
Ambrosia artemisiifolia	Ragweed	.251
Polygonum scandens	False climbing buckwheat	.186
Echinochloa crusgalli	Barnyard grass	.177
Raphanus raphanistrum	Wild radish	.115
Setaria glauca	Foxtail	.104
Panicum miliaceum	Early fortune millet	.079
Asclepias	Milkweed	.069
Rhus toxicodendron	Poison ivy	.068
Polygonum	Knotweed	.047
Smilax rotundifolia	Bullbriar	.039
Lathyrus maritimus	Beach pea	.034
Avena sativa	Oats	.020
Unidentified	Seeds	.024
Nyssa sylvatica	Black gum	.018
Plantago lanceolata	Buckhorn plantain	.017
Rumex	Curled dock	.011
Malus	Apple	.010
Fagopyrum esculentum	Buckwheat	.005
Neslia paniculata	Ball mustard	.001
Panicum capillare	Tickle grass	.0003
	Animal Matter	
Bibio sp. and Ludius sp.	Marchfly and click beetle larvae	3.071
Locustidae	Grasshopper	.234
Unidentified	Caterpillar	.018
Gryllidae	Cricket	.016
Coleoptera	Beetle	.016
Hemiptera	Bug	.016
Araneida	Spider	.004
Formicidae	Ant	.002
Pulmonata	Snail	.002

woody plants made up 42.01 per cent of the total weight. Fruits of skunk cabbage, seeds of Impatiens, unidentified tubers, etc. contributed 16.99 per cent. The seeds of weeds of cultivation, including ragweed, barnyard grass, wild radish, and foxtail amounted to only 0.72 per cent. The five leading items (corn, bayberry, skunk cabbage, arrowwood, and rose) provided 87.18 per cent of the total food. Animal matter formed 3.38 per cent. Marchfly, and click beetle, larvae provided the bulk of the animal food with 3.07 per cent, while other

TABLE 4

FALL FOODS OF THE BOB-WHITE QUAIL IN WASHINGTON COUNTY, RHODE ISLAND, BASED ON THE EXAMINATION OF 69 CROPS AND LISTED IN THE ORDER OF THEIR PERCENTAGES BY DRY WEIGHT

Scientific Name	*Common Name*	*Per Cent*
	Vegetable Matter	
Ambrosia artemisiifolia	Ragweed	41.851
Myrica carolinensis	Bayberry	13.484
Symplocarpus foetidus	Skunk cabbage	11.458
Impatiens biflora	Snapweed	8.335
Zea mays	Corn	7.639
Setaria glauca	Foxtail	2.971
Sassafras variifolium	Sassafras	2.509
Chenopodium album	Lambsquarters	2.239
Polygonum scandens	False climbing buckwheat	1.297
Arisaema triphyllum	Jack-in-the-pulpit	1.040
Quercus	Acorn	1.034
Rhus toxicodendron	Poison ivy	1.018
Viburnum dentatum	Arrowwood	.876
Polygonum persicaria	Ladysthumb	.555
Rosa	Rose	.343
Vitis	Grape	.329
Stellaria media	Chickweed	.261
Raphanus raphanistrum	Wild radish	.259
Malus	Apple	.208
Rumex	Curled dock	.196
Chenopodium	Pigweed	.177
Greens	Leaves	.155
Fagopyrum esculentum	Buckwheat	.095
Alnus incana	Alder catkins	.087
Lathyrus maritimus	Beach pea	.084
Phaseolus vulgaris	Bean	.048
Polygonum pennsylvanicum	Smartweed	.047
Avena sativa	Oats	.043
Prunus serotina	Cherry	.037
Nyssa sylvatica	Black gum	.031
Rhus copallina	Sumac	.027
Pisum arvense	Pea	.024
Neslia paniculata	Ball mustard	.022
Unidentified	Seeds	.018
Polygonum	Knotweed	.013
Triticum aestivum	Wheat	.008
Asclepias	Milkweed	.007
Juniperus	Juniper	.006
Unidentified	Lichens	.006
Panicum capillare	Tickle grass	.004
Unidentified	Bud	.003
Echinochloa crusgalli	Barnyard grass	.001
	Animal Matter	
Locustidae	Grasshopper	.458
Gryllidae	Cricket	.357
Coleoptera	Beetle	.350
Araneida	Spider	.179
Hemiptera	Bug	.057
Hymenoptera	Wasp	.023
Formicidae	Ant	.011
Pulmonata	Snail	.011

items including grasshoppers and crickets made up a very small percentage of the total.

Percentages by Weight of Food Items (Quail).—Achenes of ragweed, with 41.85 per cent, led the weight percentages

of the food found in 69 quail crops (Table 4). Bayberries with 13.48 per cent, and fruits of skunk cabbage (11.46 per cent) were next in order. Other plants contributing more than 1 per cent of the total weight were snapweed, corn, foxtail, sassafras, lambsquarters, false climbing buckwheat, jack-in-the-pulpit, oak, and poison ivy. Animal matter made up 1.45 per cent of the food with grasshoppers, crickets, and beetles, the leading items. The five chief foods of the quail (ragweed, bayberry, skunk cabbage, snapweed, and corn) made up 82.77 per cent of the diet. Eight leading constituents formed 90.5 per cent of the total.

Chemical Determinations of Fall Foods of Pheasant and Quail.—Table 5 shows the chemical composition of the leading plant foods according to this study, and of common grains included for comparison. In general, the products of woody plants, compared to the grains, have a low protein content, a varying fat content (for the most part high), a high crude fiber content, and a varying nitrogen-free extract content. Bayberries and poison ivy fruits have high fat contents of 28.2 per cent and 26.09 per cent, a high crude fiber content of 35.33 per cent and 30.10 per cent, and a low protein content of 5.09 per cent and 6.75 per cent, respectively. These analyses are based on water contents of 7.38 per cent and 3.38 per cent, respectively. Plant food with protein levels above 10 per cent include bittersweet nightshade berries, 16.06 per cent, speckled alder catkins, 14.19 per cent,

TABLE 5

RESULTS OF CHEMICAL ANALYSES OF THE MOST IMPORTANT FALL FOODS OF THE RING-NECKED PHEASANT AND BOB-WHITE QUAIL IN WASHINGTON COUNTY, RHODE ISLAND

Scientific name	Common name	Protein	Fat	Carbohydrates		Ash	H_2O
				Crude fiber	N-free extract		
		%	%	%	%	%	%
Myrica carolinensis	Bayberry	5.09	28.21	35.33	22.93	1.06	7.38
Viburnum dentatum	Arrowwood	7.69	16.26	11.48	57.66	3.37	3.54
Sassafras variifolium	Sassafras	12.00	51.41	11.85	18.78	2.42	3.54
Quercus ilicifolia	Scrub oak	10.38	15.88	3.36	65.13	1.71	3.54
Quercus rubra	Red oak	7.56	22.63	4.77	61.04	2.23	1.77
Rosa	Rose	7.94	3.98	33.18	48.76	4.48	1.65
Rhus toxicodendron	Poison ivy	6.75	26.09	30.10	32.15	1.53	3.38
Alnus incana	Speckled alder	14.19	7.42	19.66	52.58	2.17	3.98
Vitis	Grape	7.44	2.07	22.80	56.05	3.99	8.37
Solanum dulcamara	Nightshade	16.06	2.96	19.43	51.51	7.07	2.97
Smilax rotundifolia	Bullbriar	9.31	5.29	18.78	60.75	3.05	2.81
Smilax glauca	Sawbriar	10.91	7.70	18.36	57.12	2.93	3.70
Rhus copallina	Sumac	4.94	11.18	30.97	46.62	2.25	4.07
Juniperus virginiana	Juniper	8.94	14.57	29.22	40.46	2.93	3.88
Ambrosia artemisiifolia	Ragweed	18.22	12.07	38.14	23.34	4.12	3.60
Chenopodium album	*Lambsquarters	14.10	7.80	19.10	46.20	3.00	9.80
Polygonum scandens	False climbing buckwheat	9.44	2.36	8.05	73.42	1.64	5.09
Polygonum pennsylvanicum	Smartweed	9.00	3.19	15.93	67.16	1.58	3.14
Setaria glauca	Foxtail	17.69	4.48	21.61	45.02	7.70	3.50
Asclepias	Milkweed	23.00	14.67	13.35	41.05	3.56	4.37
Raphanus raphanistrum	Wild radish	8.25	10.59	49.51	31.77	2.03	7.85
Chenopodium	*Pigweed	15.00	6.80	15.20	52.50	4.20	6.30
Symplocarpus foetidus	Skunk cabbage	23.25	37.72	4.89	27.39	3.08	3.67
Impatiens biflora	Snapweed	18.69	21.82	3.49	47.31	4.41	4.28
Arissaema triphyllum	Jack-in-the-pulpit	11.44	3.30	6.51	71.64	2.84	4.27
Zea mays	*Corn	10.40	5.00	1.50	69.40	1.50	12.20
Triticum aestivum	*Wheat	11.70	2.00	2.00	71.30	1.80	11.20
Fagopyrum esculentum	*Buckwheat	10.80	2.50	10.30	62.20	2.10	12.10
Secale cereale	*Rye	11.80	1.80	1.80	73.20	2.00	9.40
Avena sativa	*Oats	12.40	4.40	10.90	59.60	3.50	9.20

*=Analysis quoted from "Feeds and Feeding" by Henry and Morrison.

sassafras fruits, 12.0 per cent, sawbriar fruits, 10.91 per cent, and scrub oak acorns, 10.38 per cent. These analyses are on an air-dry moisture basis. Red oak and scrub oak acorns, and fruits of sassafras, arrowwood, juniper, and sumac have fat levels above 10 per cent, with sassafras leading with 51.41 per cent. All of the woody plant products except the acorns have a crude fiber content of more than 10 per cent, ranging from 11.48 per cent for the fruits of arrowwood to 35.33 per cent for those of bayberry. Bayberry, poison ivy, and sassafras fruits have a nitrogen-free extract content of less than 33 per cent, and other woody plant foods range from 40.46 per cent for juniper berries to 65.13 per cent for scrub oak acorns.

The seeds of weeds in comparison to the common grains have for the most part a higher protein level, a higher fat content, a very much higher crude fiber content, and varying nitrogen-free extract which, in general, however is about the same as that of the grains. Weed products having the highest protein contents are milkweed seeds, with 23.0 per cent; ragweed achenes, 18.22 per cent; foxtail seeds; 17.69 per cent; pigweed seeds, 15.0 per cent; and lambsquarters seeds, 14.1 per cent. Foods from milkweed, ragweed, and wild radish have high fat contents, all more than 10 per cent while those from the other weeds analyzed have a fat content which is about the same as that of the grains. With the exception of those of false climbing buckwheat, all the weed seeds have a very high crude fiber content ranging from 13.35 per cent for milkweed to 49.51 per cent for wild radish. The seeds of false climbing buckwheat, Pennsylvania smartweed, and pigweed have a nitrogen-free extract content of more than 50 per cent; those of lambsquarters, foxtail, and milkweed from 40 to 50 per cent; and those of ragweed and wild radish less than 30 per cent.

The fruits of skunk cabbage and snapweed have a relatively high protein level compared to that of the common grains, 23.25 per cent and 18.69 per cent, respectively. Their fat levels are four and seven times higher, respectively, than that of corn (five per cent). The crude fiber contents of these foods compare favorably with that of the common grains, while the nitrogen-free extract is much less.

Table 6 shows the approximate composite analysis of items aggregating 99.6 per cent of the weight of the pheas-

TABLE 6

CHEMICAL COMPOSITION LEVELS OF THE FALL FOODS OF PHEASANTS AND QUAIL BASED ON ITEMS AGGREGATING 99.6 PER CENT OF THE TOTAL WEIGHT OF THE PHEASANT FOOD AND 99.0 PER CENT OF THE QUAIL FOOD FOUND IN THE FALL FOOD-HABIT STUDY

Bird	Protein	Fat	Carbohydrates		Ash	H_2O
			Crude fiber	Nitrogen-free extract		
Pheasant	12.90	15.78	17.48	44.97	2.09	6.78
Quail	16.36	18.08	24.41	33.15	3.43	4.57

ant food and 99.0 per cent of the quail food for the months of November and December. Cultivated grain analyses were taken from Henry and Morrison (12), and the grasshopper analysis of Hosley (15) was used for the animal matter. Analyses of grass leaves and unidentified tubers were approximated. The protein levels are surprisingly high, 12.9 per cent for pheasants and 16.36 per cent for quail. Fat contents were very high, being 17.48 per cent for pheasants and 24.41 per cent for quail. Crude fiber and nitrogen-free extract combined made up about 60 per cent in each case, with crude fiber being 17.48 per cent for the pheasants and 24.41 per cent for the quail. These results showed a moisture content of 6.78 per cent for pheasant foods and 4.57 per cent for those of the quail; doubtless somewhat lower than might have been the case in the actual environment as the chemical determinations were based on air-dry material.

DISCUSSION OF RESULTS

Cultivated Grains.—Corn was the leading item in percentage by weight of the pheasant's food (34.8 per cent) and made up practially all of the grain taken; ten of the 32 pheasants examined had corn in their crops. For the most part this grain was picked up in corn fields after they had been harvested, but in one instance the corn probably came from a poultry farm because wheat also was found in the same stomach and this grain is not grown in the section where the pheasant was killed. In two instances, corn was the only item found in the crops; No. 4 taken November 9, 1937 had 23 kernels and No. 26 collected November 3, 1939 held 122. In eight cases corn, other grains, and seeds of associated weeds were found while in the other two corn was subordinated to food products from woody plants. No. 12 contained 487 bayberries, 63 rose seeds, 10 grass leaves, and 33 corn kernels; and No. 32 held 149 achenes of wild buckwheat, 98 seeds of snapweed, 72 of millet, 61 unidentified tubers, 48 plantain seeds, 18 skunk cabbage berries, 10 dock seeds, 7 bindweed seeds, 6 oat grains, 5 bayberries, 3 rose hips, 2 apple seeds, one alder catkin, and 27 corn kernels.

About one out of every three pheasants taken had consumed corn and this figure is low compared with reports of investigators in other sections of the country. Swenk (22) found that corn made up 67 per cent of the year's food in Nebraska; Hicks (14) in Ohio, 55 per cent; and Bennett and English (1) in Pennsylvania, 54 per cent. In Minnesota, Fried (9) reported 49.5 per cent of the year's food to be corn, and Dalke (5) found Michigan pheasants to consume 33 per cent.

The seemingly low percentage of corn found in this study can be explained by the comparative scarcity of this crop in Washington County. If more corn were available, Rhode Island pheasants probably would consume considerably more than indicated by this study.

The bob-whites utilized corn as food to a lesser extent than the pheasants. Only 7.64 per cent of their total food consisted of this grain, which was taken by about one out of every five birds. The quantities eaten were usually small, the largest number of kernels taken by one bird being eighteen. The percentage stated is lower than that reported in Judd's general study (16), 11.96 per

cent, and that recorded by Hick's (13) for Ohio bob-whites, 11 per cent. Corn formed 21 per cent of the quail's food according to the Pennsylvania study by Bennett and English (1), considerably more than that for the Rhode Island quail here reported upon.

Corn is considered an excellent winter staple for game birds, although it is not in itself a well-balanced ration. Rhode Island flint corn yields upon analysis approximately 10.4 per cent protein, 5.0 per cent fat, 1.5 per cent crude fiber, and 69.4 per cent nitrogen-free extract. The protein is out of balance with the fattening constituents, fat, and carbohydrates, a feature desirable in a winter food but objectionable in a reproduction ration. When supplements are available such as other grains, greens, fruits, and animal matter, it is doubtful if any other single food is as beneficial to wild game as is corn.

Other grains formed only 2.01 per cent of the pheasant's, and only 0.22 per cent of the quail's, food. Wheat, composing 1.14 per cent of the pheasant diet, was found in two crops and, as stated was feed as no wheat is known to be grown in the section where the birds were killed.

Rye and oats were taken by one pheasant and made up less than one per cent of the total food by weight. Oats were eaten by four quail but made up only 0.04 per cent of the total food. A small amount of buckwheat also was consumed. As in the case of corn, the availability of these cereals is very low. Gilbert's land utilization study of Washington County showed that only 719 acres of cereals were under cultivation in 1937.

Other studies have brought out a much greater utilization of these cereals than is shown by this study. Wheat was the most important food of Colorado's pheasants as reported by Burnett (2). Besides corn—wheat, barley, oats, flax, rye, and millet were the most abundant foods disclosed by Severin's (21) food-habit study of the pheasants in South Dakota. Swenk (22) in Nebraska found oats, barley, and wheat to form 9 per cent of the pheasant's annual food. Dalke (5) reported 41 per cent of the food of Michigan pheasants to consist of wheat, barley, beans, oats, and buckwheat. Hicks (13) found wheat to compose 6 per cent of the quail's diet in Ohio, and Bennett and English (1) reported that wheat formed 9 per cent and buckwheat 5 per cent of the food of this species in Pennsylvania.

The chemical makeup of wheat, buckwheat, rye, and oats is similar to that of corn, with protein slightly higher, 11.7 per cent for wheat, 11.8 per cent for rye, and 12.4 per cent for oats as compared with 10.4 per cent for corn. The fat percentage is about half that of corn, ranging between 1.8 per cent and 2.5 per cent for rye, wheat, and buckwheat to 4.4 per cent for oats. Except for high percentages in buckwheat and oats with 10.3 per cent and 10.9 per cent, the levels for crude fiber in these grains are about the same as that for corn. The nutritive value of these cereals as game bird feeds is rarely questioned and oats are considered better than corn as a single food for poultry.

Seeds.—The bob-whites involved in this study utilized the seeds of weeds a great deal more than did the pheasants —to the extent of 48.6 per cent contrasted to 0.72 per cent of their respec-

tive diets. Achenes of ragweed were by far the most important item consumed by the quail, forming 41.85 per cent of the total food by weight and being taken by 52.2 per cent of the birds examined. Seeds of yellow foxtail and lambsquarters made up 2.97 per cent and 2.24 per cent, respectively, of the quail's food. Others found in small quantities were those of ladysthumb, chickweed, wild radish, curled dock, pigweed, Pennsylvania smartweed, ball mustard, knotweed, milkweed, and barnyard grass.

The quantity of weed foods available for game birds is governed by the amount of land in cultivation and the practices of farm management, as the extent of "clean farming," fall plowing, etc. From the results of this study it would seem that the bob-whites utilized this source of food to the full extent of its availability, only 3 per cent of Washington County being under cultivation. Studies in other regions have shown a slightly higher utilization of weed seeds for food.

Other pheasant food habit studies also have disclosed that weed seeds are eaten to a greater extent than was found in this research. Most of the reports of other investigators record weed seeds as making between 4 and 11 per cent of the pheasant's food.

No literature is available on the digestibility of weed seeds by game birds but their chemical composition indicates a high nutritive value, especially as a source of fat and protein. Those of ragweed, lambsquarters, foxtail, milkweed, and pigweed lead in this respect. Achenes of false climbing buckwheat and Pennsylvania smartweed are lower than the others in fat and protein but considerably higher in nitrogen-free extract.

The nutritive value of weed seeds makes them excellent game bird food but the detriment of weeds to agriculture renders it impracticable in most cases to favor them in wildlife management. In other words, game birds help the farmer by cleaning up weed seeds, but the wildlife manager as a rule cannot help the birds by providing weeds to feed them because he would thus injure the farmer. Ragweed, the leading quail food, is not only a pest in agriculture but is also the cause of much hayfever.

One of the weeds, producing game bird food, namely, false climbing buckwheat is not considered a noxious weed in Rhode Island. Its growth is more or less restricted to waste lands and fence rows. Tolerance and encouragement of its growth would provide game birds with a food comparable in chemical composition to the cereals.

Native Plants.—These provided the major portion of the pheasant's fall food supply and also a large part of the quail's diet—69 and 41.8 per cent, respectively.

Bayberries were taken by one out of every two pheasants and almost as frequently by quail. The weight percentages are also significant, 21.0 per cent for pheasants and 13.5 per cent for quail. Some of the pheasants consumed large quantities of these fruits. Only eight of the crops examined contained fewer than 100 and in one instance a pheasant had taken 739 bayberries. Large quantities were not common in the quail crops; nineteen of the thirty-four found with bayberries contained

less than 27 seeds and only three contained more than 100.

Much of the brush land in Washington County contains a large proportion of bayberry bushes. Both the pheasant and quail utilized these plants not only as a source of food but also for cover. Whether the hunting season caused the birds to seek bayberry cover and then feed on the conveniently accessible berries is difficult to determine. On the one hand, the figures of other investigators show that neither the pheasant nor the quail usually take such large quantities of wild plant food as brought out in this study, and on the other, the land-cover figures of Washington County show that foods available from brushland are far greater than those from other sources. The results confirm the widely evident importance of availability in influencing the dietaries of birds. As to the nutritive value of bayberries, it must be said that the protein and nitrogen-free extract are very low and the crude fiber is very high, representing for the most part the shell of the seed which is very hard. The high fat content indicates a potential source of energy but because it is derived from a seed coating of waxy composition its digestibility seems questionable. Nevertheless, bayberries are extensively consumed not only by the game birds here treated but they are also the main dependence of northward wintering myrtle warblers and tree swallows. Studies on their digestibility should be continued.

The fruits of arrowwood also provided a substantial percentage of the non-cultivated foods revealed by this study. Pheasants utilized these berries in larger quantities than did the quail. One pheasant crop contained 782 of them and two others 309 and 231, respectively, indicating that their palatability is high. Quail consumed smaller quantities, usually less than eight berries per bird, although two were found to have taken as many as 21 and 25. The brushlands of Washington County contain a large number of arrowwood plants, and as in the case of bayberries, they serve also as cover. It would seem that the availability of these plants has governed the utilization of their fruits as food by the pheasants and quail dealt with in this study.

Chemical analysis shows that while this fruit is better in nutritive elements than the bayberry, it is hardly qualified to be a staple food of the game birds. The protein content is less than 8 per cent but the fat and nitrogen-free extract are relatively high and the crude fiber is only 11.48 per cent. This analysis shows that arrowwood has definite value as a supplement in the diet of the pheasant and bob-white.

Sassafras drupes were eaten only by the quail. These fruits made up 2.5 per cent of the bob-white's diet and were taken by 11.6 per cent of the birds examined. Three of them consumed the relatively large numbers of 68, 24, and 20 seeds, each. The chemical composition of these fruits shows that their fat content is very high (51.41 per cent); if their digestibility is also high these berries would be a very valuable addition to the diet of any gamebird. The protein level is relatively high (12 per cent), and the crude fiber fairly low—a desirable quality.

Rose hips were consumed frequently by the pheasants, about one out of every five birds examined having eaten

them. Quail utilized this item less frequently. About 5 per cent of the pheasant's food and less than 1 per cent of the quail's food were made up of these fruits. Rose hips were generally taken in smaller quantities than other constituents of the crop contents. Specimen No. 12, taken December 19, 1937, is typical in containing 80 bayberries and 11 rose hips along with two pieces of grass, one berry of skunk cabbage, and one cherry stone.

The nutritive value of rose hips as indicated by chemical analysis is relatively low. The protein level of 7.9 per cent and the fat level of 3.9 add little to the dietary of a game bird and the large amount of crude fiber, 33.2 per cent, is undesirable.

Acorns were taken by one of the pheasants and two of the bob-whites studied. Only the meat had been eaten and it had probably been obtained from acorns opened by rodents. The chemical analysis shows acorns to be a valuable food. As nutritious as acorns might be to the birds, it is doubtful if they can be considered as a regular dependence because of the necessity of intervention by rodents or other agents to make them available.

Poison ivy fruits were taken rather frequently by the quail, 17.4 per cent of the birds examined having them in their crops, to the extent, however, of only 1.02 per cent of the total food by weight. Only one pheasant had taken these berries. The small quantities eaten seem to indicate that their use is incidental. Poison ivy fruits are very similar in chemical composition to bayberries.

Other foods derived from woody plants occur less frequently and have low weight percentages. These items include cherry stones, grape seeds, speckled alder catkins, bullbriar berries, parts of apples, blackgum seeds, and sumac and juniper berries. Even though the availability of these foods is sometimes great, in no case did they form an important part of the food consumed by either a pheasant or a quail. It seems that they are only incidentals in the diet.

Speckled alder catkins have the high protein content of 14.19 per cent, which should qualify them as a desirable wildlife food. As for the other species listed, all have high crude fiber and low protein which make them less important as evaluated by their chemical analyses.

Skunk cabbage fruits were one of the most important foods taken by both the pheasant and quail, one out of every four pheasants and one out of every five quail having eaten these berries. The percentages of total weights, 13.4 and 11.5, were also high. Pheasants that had taken them consumed an average of eight berries. This plant is restricted to swamps, sloughs, and swales and these areas should be preserved because of the amount of desirable wildlife food that they produce.

Skunk cabbage fruit is shown to be a valuable food also by its chemical make-up. The protein level of 23.25 per cent is higher than that of any other vegetable food taken by either the pheasant or quail and the fat content of 37.72 per cent is second only to that of sassafras drupes. The low crude fiber content of 4.89 per cent is also desirable.

Seeds of snapweed proved to be a very important food to the quail included in this study. They were the fourth ranking item in weight percen-

tage with 8.3 per cent. The pheasants consumed a much smaller quantity by weight percentage but 18.8 per cent of the birds examined had taken these seeds. Seven bob-whites had eaten in excess of a hundred seeds each and four of them had taken more than three hundred apiece, indicating high palatability. The chemical composition of snapweed seeds qualifies them as one of the most nutritious foods taken by the birds studied. In general, their composition is similar to that of skunk cabbage, showing the high protein level of 18.69 per cent, and the high fat content of 21.82 per cent. Skunk cabbage, like snapweed, requires a damp environment as in swamps and swales and it will continue as a source of valuable wildlife food where suitable environments are not destroyed by grazing, brush cutting, or burning.

Of the other native plant foods disclosed by this study, only jack-in-the-pulpit was represented in large enough quantities to be of importance. The chemical composition of the berries of this plant, in general similar to that of corn, shows that they are a valuable addition to the diet of gamebirds.

Animal Matter—The animal matter taken by the pheasants and bob-whites studied was similiar to that found by other investigators of the fall food habits of these birds. Only a small quantity of animal matter was taken by either species during December, which is to be expected as animal life is less available in cold weather. Marchfly and click beetle larvae made up the bulk of the animal diet taken by the pheasants, forming 3.1 per cent of the total food. The remaining 0.3 per cent of animal matter was made up of grasshoppers, caterpillars, crickets, beetles, bugs, spiders, ants, and snails.

Bob-whites took a smaller percentage of animal food than the pheasants, only 1.45 per cent. This consisted of the same items eaten by the pheasants except that no larvae were included.

Chemical Composition of the Foods.—Chemical analysis does not alone suffice to demonstrate the complete nutritive value of a food. It must be supplemented by biological analysis; that is, by feeding experiments in which effects on growth, health, and fertility are determined. Nevertheless, the data as to chemical composition reported in this study indicate the potential nutritive value of the various plant foods. As no direct research has been undertaken on the nutritive requirements of gamebirds in the wild, it is difficult to determine whether a diet such as was found for pheasants and quail in this study is sufficient to provide for normal energy needs and repair of tissues. Light may be thrown upon the adequacy of the diet by indirect comparison with that of the pheasant in other states. Food habit studies of pheasants elsewhere have shown that this bird consumes about 75 per cent cultivated grains, 7 cent weed seeds, 7 per cent animal matter, 6 per cent fruits and 10 per cent miscellaneous. This proportion of foods would yield a protein level of approximately 15 per cent, which is higher than that shown in this study for the pheasant diet; a fat content of about 3.5 per cent, which is much lower than that revealed by this study; and a much higher level of nitrogen-free extract, about 65 per cent. The considerable differences in pheasant food composition may be explained by the digesti-

bility of the constituents such as proteins, fats, or carbohydrates and not in their percentage levels.

In the quail food-habit studies here and elsewhere there is not enough difference in the type of food taken to call for similar comment.

In Washington County, where only three per cent of the total area is under cultivation, knowledge of the nutritive value of the native plant foods preferred by game birds is essential to a restoration program. Even if the farming activities practiced here were beneficial, they would be of limited importance as only a relatively small number of game birds could exist on the food available from plants of cultivation. All hope for producing an abundant food supply lies in the relatively large areas of waste and brush lands. With knowledge of the potential nutritive value of the plant foods based on chemical analysis, the desirable species can be encouraged.

The writer does not believe that any single plant food can suffice as a sole diet for game birds. Even corn, with all its desirable features, has proved deficient when fed alone to poultry. But the writer does believe that native foods should be made available in proportion to their nutritive values.

Inasmuch as the food habit and nutritive studies thus far made are not complete, only a tentative list of desirable plant food producers can be offered and then only as supplements to the grains which are true staples. These include arrowwood, false climbing buckwheat, jack-in-the-pulpit, nightshade, sassafras, skunk cabbage, snapweed, and speckled alder.

CONCLUSIONS

1. The ring-necked pheasant, often a predominantly granivorous bird, in Rhode Island obtains less than 40 per cent of its food from grain.

2. The bob-white consumes large quantities of weed seeds but the proportion revealed by this study was less than that found in other investigations.

3. Availability for the most part determined the relative percentages of various items of food taken by the pheasant and quail.

4. In general, the chemical composition of weed seeds shows them to be dietetically superior to the common cereal grains in protein and fat content and inferior in crude fiber and nitrogen-free extract.

5. With few exceptions, the parts of woody plants eaten are inferior to the common cereal grains as evaluated by their chemical analysis, having a lower protein content and a higher fat and crude fiber level.

6. Chemical analyses indicate a very high nutritive value for skunk cabbage fruits and snapweed seeds.

7. A large percentage of the pheasant's food has a low nutritive value according to chemical analyses. Fruits of bayberry, poison ivy, rose, cherry, and grape, which form 27.36 per cent of the fall food are in this category.

8. The approximate chemical composition of the total fall food of the ring-necked pheasant is below the requirements of birds held in captivity, but more investigation, especially biological analysis, is necessary to determine whether the food supply as found in this study is adequate to meet the nutritive needs of the species.

9. The chemical composition indicates a high nutritive value for the fall food supply of the bob-white quail as revealed by this study.

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FACTORS CAUSING RODENT DAMAGE TO TREE PLANTATIONS IN SOUTHEASTERN MINNESOTA

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A survey of rodent damage to seedlings in areas planted by the Soil Conservation Service in southeastern Minnesota revealed that tree species, density of cover, slope direction, and past land use are the principal factors that influence damage by mice and rabbits.

The areas planted in a program of erosion control and good land use, were established in soil conservation demonstration projects and CCC camps to protect depleted cultivated fields, overgrazed pastures, and gullied areas. After these areas had been exempt from fire and grazing for a year or two, they often became covered with rank growths of herbaceous vegetation that provided excellent habitat for rabbits and mice.

Because little was known of the role of these animals in such areas, the author adopted a method of sampling the plantations to determine the extent of damage and how it was affected by ecological factors. The procedure used was a modification of the standard method of the Soil Conservation Service for taking tree survival counts.

Procedure and Results

Data were collected by a two-man crew, an observer and a recorder. The recorder paced a prearranged length, usually 5 or 10 paces, depending on the size of the plantation. The observer would then examine and call out the species and type of damage of the first ten trees along the line for the recorder to note. The observer then went to the end of the first unit, the recorder paced another length, and observation was made of the first 10 trees in it. The lines were run at right angles or diagonally across the planted rows in order to sample all species and parts of the plantation. The size of plots varied from 0.2 to 17.3 acres. Samples, from ten per cent to complete coverage, were taken in inverse proportion to the size of the areas.

It was assumed that mice (probably of the genus *Microtus*) attacked the stems and that cottontail rabbits and white-tailed jackrabbits damaged the tops. This might have been accurately ascertained at the time of examination, but the observers were not trained to identify the various types of damage. There was a marked difference between the average amounts of stem (36.6 per cent), and top, damage (15.3 per cent).

For the record, damage was classed under the following four heads: no damage, stem damage, top damage, or both damaged. Each tree was recorded only once.

The inspections were made during the late spring of 1939 on plantations at the Zumbrota, the Red Wing, and the Lake City CCC camps, and at the

[1] Credit is due the following men of the Soil Conservation Service: Harry T. Callinan, H. Ray Cline, Thomas R. Evans, and Dewey V. Hahn for assistance in collecting the data, and to Dr. Horace L. Thomas for suggesting methods of analyzing them.

The paper was written by the author when employed as Area Biologist, Soil Conservation Service, Faribault, Minn.

Caledonia and Faribault demonstration projects, and relate to damage done to 42 plantations during the winter of 1938–39. An attempt was made to survey areas representing each year's plantings from the first made in 1935 to those planted in 1938.

In addition to noting the damage done to each species, the past history of the plantation was recorded, as to dates of isolation and of planting; as well as the number of trees planted; size of the area; its exposure or direction in which the plantation sloped; method of ground preparation; if cultivated, the date; past land use; the density of present cover classified as thin, moderate, and heavy; and type of cover whether grass, brush, or scattered trees.

The data were summarized by each of the above factors, and for all plantations having the same conditions, totalled, and percentages determined for the totals in each damage class.

Results of the survey are given in percentages in order to permit comparisons as it would be impossible to get a true comparison according to the number of each kind of tree because of the random method of sampling. This resulted in large numbers of certain species being examined because they were planted in greater numbers.

The collected information was first studied according to the geographic areas involved to learn whether there were wide variations between them. However, the percentage of trees not damaged varied only from 49.1 at Zumbrota to 52.7 at Faribault, with an average of 52.3 for all locations, indicating that there was little difference in the extent of damage between locations.

The next factor considered that might have influenced the degree of damage was the year of isolation. It was hoped that the same number of sites could be examined for each year but that goal was not quite reached; the plots studied according to year of planting were for 1935 (5), 1936 (12), 1937 (13), and 1938 (12). Upon analysis of the percentage of trees not damaged, it was found that there was no correlation with age. The 1935 plantations had 46.8 per cent not damaged; 1936, 58.9; 1937, 51.8; and 1938, 44.3 per cent.

It is quite possible that if the plantings had covered a longer period and more samples could have been taken for each year, cycles of damage might appear. Such a result has been pointed out by the University of Oxford studies (5) of plantations in England, in correlation with mouse populations that fluctuated in three- or four-year cycles up to a period of 10 to 16 years, at which time the trees shaded out the herbaceous cover.

Assuming that the rodent populations might have varied with the presence of herbaceous vegetation, the method of site preparation on which it was dependent was the next factor considered. Unfortunately, the number of areas prepared by plowing furrows in which the trees were planted were too few due to steepness of slope, presence of numerous gullies, and shallow soils. Only four were prepared in this manner as compared to 36 "scalped" sites. The latter method consisted of removing by hand tools the grass and debris from spots two feet square. The remaining two plantations had received a combination of these treatments so they were not included in the summary.

Examination of Table 1, relating to the percentage of damage in the plantations sorted for the preparation factor, shows that on scalped areas, 65.1 per cent, and in the furrowed plots, 42.1 per cent, of the trees escaped damage. Stem damage in the furrowed, was 46.1 per cent as compared with 33.2 per cent in scalped, areas. The corresponding figures for top damage were 9.4, and 12.1, per cent, respectively. No definite conclusions can be drawn from these data because of the small number of furrowed plantations. It appears, however, that furrowing tends to guide mice to the trees.

TABLE 1

PERCENTAGE OF DAMAGE AS AFFECTED BY METHOD OF SITE PREPARATION

Method	Number of plantations	Damage				Total trees
		None	Stem	Top	Both	
Furrowing	4	42.1	46.1	9.4	2.5	2,231
Scalping	36	54.1	33.2	12.1	0.7	14,363
Basis of samples	40	8,707	5,790	1,948	149	16,594
Percentages of total	—	52.5	34.9	11.7	0.9	—

Table 2 shows the percentage of damage by plant species. Again it is well to point out that some of the species did not occur frequently enough to give a true picture of their susceptibility to damage. It is evident, however, that the mice showed decided preference for wild plum (*Prunus virginiana*), Chinese elm (*Ulmus pumila*), and soft maple (*Acer saccharinum*), the stand of each of which was more than 60 per cent damaged. These results are consistent with the findings of Siegler (4) who ranks black cherry and wild plum high among preferred foods for mice. Legumes, represented by black locust (*Robinia pseudoacacia*) and caragana (*Caragana arborescens*) were relatively little damaged and the pines, as a group, suffered least, the percentage of molestation ranging from 6.0 for jack pine (*Pinus banksiana*) to 17.2 for ponderosa pine (*Pinus ponderosa*).

Rabbits showed a decided preference for rose (*Rosa setigera*), hackberry (*Celtis occidentalis*), and green ash (*Fraxinus pennsylvanica*, var. *lanceo-*

TABLE 2

PERCENTAGE OF DAMAGE BY PLANT SPECIES IN ORDER OF SEVERITY

Species	*Total number examined*	*Stem damage*	*Top damage*
Wild plum	133	69.9	7.5
Chinese elm	58	63.8	0.0
Soft maple	214	62.6	0.0
Black cherry	515	49.5	5.3
Black walnut	1,537	42.7	7.0
Hackberry	339	39.8	20.1
Green ash	11,972	35.1	13.7
Chokecherry	17	33.3	5.6
Butternut	11	27.3	0.0
Black locust	1,272	23.3	6.1
Caragana	525	22.5	4.2
Ponderosa pine	64	17.2	7.8
Scotch pine	168	15.4	5.4
Rose	46	15.2	23.9
Russian olive	36	13.9	5.5
White pine	51	11.8	3.9
Jack pine	84	6.0	0.0
Averages	—	36.6	15.3
Totals	[1]17,043	5,999	1,984

[1] Also examined two woodbine, one "spruce," and one white oak. Total trees not damaged, 8,908; damaged to both stem and top, 152.

lata). None of the Chinese elm was attacked by these animals although it is sometimes a preferred food (1). The genus *Prunus* was not attacked by rabbits to the extent that was expected. Siegler (4) ranks black cherry and rose among the preferred foods of rabbits, but indicates a correlation between soil types and degree of palatability. Unfortunately soil types were not recorded during the present study.

The tallies were next sorted on the basis of the density of herbaceous cover at the time of the examination (Table 3). Density was arbitrarily classed as thin, moderate, and heavy. There was progressively more mouse damage as the cover became more dense, the percentage varying from 13.1 in thin, to 45.4 in heavy, cover. Presumably, greater concentrations of mice in the heavier vegetation accounts for the trend. Top damage by rabbits had just the reverse relationship, amounting to 14.7 per cent in thin, and 8.8 per cent in heavy, cover. Rabbits are probably more able to find the seedlings in the thin vegetation where also there is less of other foods.

The results of the surveys were also studied in relation to exposures of the plantations or the directions in which they sloped. Exposures from west to northeast were grouped as north, those from east to southwest as south, and flat land as well as sites sloping in many directions, were put under a heading of all exposures.

Summary of the data in Table 4 indicates that the percentage of damage

TABLE 3

PERCENTAGE OF DAMAGE IN RELATION TO DENSITY OF COVER

Density of vegetation	Number of plots	Damage				Total trees
		None	Stem	Top	Both	
Thin	5	72.1	13.3	14.7	0.1	3,264
Moderate	15	49.9	36.3	12.6	1.2	7,531
Heavy	22	44.8	45.4	8.8	1.0	6,252
Basis of samples	42	8,911	6,000	1,984	152	17,074
Percentages of total	—	52.3	35.2	11.6	0.9	—

TABLE 4

PERCENTAGE OF DAMAGE IN RELATION TO EXPOSURE

Exposure	Number of sites	Damage				Total trees
		None	Stem	Top	Both	
North	12	45.2	43.1	10.9	0.9	5,534
South	20	64.8	22.7	11.9	0.6	7,613
All aspects	10	37.8	48.6	12.3	1.4	3,900
Basis of samples	42	8,911	6,000	1,984	152	17,047
Percentages of total	—	52.3	35.2	11.6	0.9	—

by mice varied from 22.7 on south, to 43.1 on north, slopes. Snow is much deeper and lies longer on the north slopes and allows the mice to continue their destructive activities through a longer period. The total snowfall at Faribault was 36 inches. The first lasting snow occurred in the middle of November and there was a coating on the ground until the middle of April. At Lake City there was 0.1 inch on November 28, about 3 inches in December, and 12 inches in the early part of March.

Considering the data in the light of past use of the plots, classifications of cultivated fields (including hay in rotation), pasture, and idle land were used. The summary of the percentages of damage (Table 5) indicates that mice caused more injury in areas formerly cultivated (61.4 per cent), and only about half that much in plantations formerly used as pasture (32.9 per cent) or left idle (31.0 per cent). The plots in this third class were areas that had been abandoned because of gully or sheet erosion. The results seem to indicate that mice are prone to frequent croplands probably for the more bountiful food supply. Rabbits again reversed the order of mouse damage, doing least in cultivated field (6.4 per cent); a medium amount in pasture (10.8 per cent), and most in idle areas (15.7 per cent). This would indicate that cover of a permanent nature attracted more rabbits, a finding correlated with that of Phillip's (3) in Oklahoma where cottontail rabbits preferred undisturbed grassland.

TABLE 5

PERCENTAGE OF DAMAGE ACCORDING TO PAST LAND USE

Past land use	Number of sites	Damage				Total trees
		None	Stem	Top	Both	
Cultivation	5	30.8	61.4	6.4	1.4	1,662
Pasture	29	55.4	32.9	10.8	0.9	10,972
Idle	8	52.7	31.0	15.7	0.6	4,413
Basis of samples	42	8,911	6,000	1,984	152	17,047
Percentages of total	—	52.3	35.2	11.6	0.9	—

DISCUSSION

In order to test whether any two factors in combination were responsible for the results, the plantations were considered with respect to the more effective factors: namely, past land use, exposure, and density of vegetation. Taking the combination of conditions ideal for mice, namely, a cultivated field facing north or in all directions, and with dense herbaceous cover, only one plantation had all of them. For rabbits, a site formerly idle, having all exposures, and with thin vegetation would seem to be ideal, but no plantation examined met these requirements. It indicated, therefore, that no combinations of factors caused distortion and the data are reliable.

From the analysis of conditions on

the plantations, it is apparent that mice may do considerable damage. Just how severe in its eventual effects this may be is unknown at this time. Should a similar study be carried out again, trees severely damaged should be marked in such a way that a survival count could be made.

Not all of the trees died that might be classed as severely attacked for later casual examination disclosed individual green ash and black cherry that were completely girdled had sent out sprouts from the root collar. This may result in a scrubby tree, however, if the process is repeated too often.

The survey indicates the possibility of ecological control of rodents by using only the less favored plant species and by regulating cover so that it will not furnish ideal habitat for the destructive animals.

SUMMARY

1. Woody plantations made by the Soil Conservation Service for erosion control, in southeastern Minnesota suffered about 47.7 per cent attack by field mice and rabbits.

2. Surveys taken on five different areas indicated little difference in the damage in relation to geographic location.

3. There was also no appreciable difference in the percentage of trees damaged according to age of the plantations (up to four years).

4. Considering damage in relation to the method of site preparation, the results showed "scalping" to be preferable to furrowing by 23 per cent. The difference was in damage to the stems, but the conclusions may be questionable on account of the small number of furrowed plantations available for study.

5. The stems of more than 60 per cent of the wild plums, Chinese elms, and soft maples were damaged while the pines suffered least (6 to 17.2 per cent). Top damage was more frequent for rose, hackberry, and green ash.

6. On the basis of density of cover classed as thin, moderate, and heavy, damage by mice became progressively worse as the density of surrounding vegetation increased, while that by rabbits became less.

7. Plantations sloping to the north suffered the greatest damage by mice. Rabbit attack varied little with exposure.

8. Plantations on areas retired from cropping suffered most from mice and least from rabbits. On former pasture and idle lands, conditions were more favorable for rabbit attacks and less so for those of mice.

9. Conditions most conducive to damage by mice in the areas studied are on lands with north-facing or no slope, formerly cultivated, covered with dense herbaceous vegetation, and planted to such species as wild plum, Chinese elm, and soft maple. Ideal conditions for rabbit attack exist on a formerly idle area, with thin vegetation, planted to rose, hackberry, and green ash.

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LYMPHADENITIS IN NEW YORK COTTONTAILS[1]

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On January 27, 1939, a cottontail collected in Ellicott Township, Chautauqua County, New York, was sent in by Game Protector Allan G. Reid. The rabbit was suspected of having tularemia and was forwarded to the Pathology Laboratory at the New York State Wildlife Research Center for diagnosis. Autopsy revealed a swollen necrotic spleen and extreme enlargement and necrosis of the axillary lymph nodes on both sides. The finding seemed to warrant further study on the nature of the malady and of its incidence in the rabbit population. Accordingly Ralph H. Smith, leader of the Pittman-Robertson Project on the Management of Cottontails in New York State, went to Ellicott Township for the purpose of live-trapping cottontails. His efforts (Feb. 7–March 19, 1939) resulted in the capture of 84 specimens which were shipped to the laboratory for autopsy. Fourteen of these had lymphadenitis[3] in various stages of development. A short time later (March 21–April 15, 1939) Smith collected 112 cottontails from Wolcott Township, Wayne County, three of which had the infection. Following is a discussion of these seventeen cases as well as of four others collected elsewhere in the state and of eight instances of sub-cutaneous abscesses without lymph node involvements.

In most of the cases, enlargement and necrosis of lymph nodes was limited to the mandibular and axillary regions. The enlargement and the extent of necrosis ranged from a single, slightly enlarged and partially necrotic mandibular node, to a heavy, bilateral involvement of both mandibular and axillaries in addition to extensive necrosis and swelling of the spleen. Table 1 records the distribution of the necrotic foci revealed by autopsy and gives a few explanatory remarks. There was a strong tendency for the disease to remain localized within the lymph nodes. In only three instances out of twenty were any of the vital organs affected in association with the nodular involvement. Only one of the four heart lesions found was associated with other necrotic foci. However, two of these were healed lesions in the myocardium so that in other instances previous association with other foci may well have been obscured by early healing. Dr. E. K. Le Dune, former pathologist of the Bureau, noted one case of metastasis to the kidney. In no instance was the liver affected and in only one case did we find the lung involved. This abscess, no larger than a small pea, was not visible on the lung surface; it was found by splitting one of the larger bronchi. In all five cases in which the spleen was affected, necrotic lymph nodes coexisted.

[1] Contribution from the Wildlife Research Center, Bureau of Game, New York State Conservation Department.

[2] I wish to express my appreciation to Ralph H. Smith for his field work in connection with this study and to my laboratory colleague, Dr. Frans C. Goble for kind cooperation.

[3] The term "lymphadenitis" is used for this disease because of the frequency with which it is found affecting the lymphatic system.

The highest observed incidence of lymphadenitis was that in Ellicott Township, Chautauqua County, where 16.6 per cent of the cottontails examined were infected. Among the 112 cottontails collected in Wolcott Township, Wayne County, 2.6 per cent were affected. Intensive collection was done in these two areas.

CAUSATIVE ORGANISM

Streaks were made from affected nodes on plain agar and egg yolk media and pure cultures of a strain of *Staphylococcus aureus* were grown. Guinea pigs, each injected with material from a different rabbit, were innoculated as follows:

1. Sub-cutaneous injection of 0.2 cc. of cheesy contents of necrotic spleen.
2. 0.1 cc. suspension from necrotic mandibular node.
3. 0.3 cc. suspension from core of axillary node.
4. 0.2 cc. suspension from core of lumbar node which had been preserved for 24 hours in glycerin.
5. 0.3 cc. suspension from core of mandibular node of guinea pig No. 3, preserved in glycerin for six days before being used.

Results: Only Nos. 3 and 4 reacted. No. 3 was autopsied five days after injection. The spleen, liver, lungs and kidneys were unaffected. There was some necrosis at point of injection in the left inguinal region and a swollen inguinal node; two cervical nodes were swollen on the right side near shoulder and one node under the right malar prominence. Swollen nodes contained a soft, greenish-white purulent material. In animal No. 4 after ten days, an inguinal node near the point of injection became greatly enlarged, ruptured spontaneously after four weeks, then drained completely and healed within a week. No swellings appeared elsewhere.

Agar streaks were made from the affected nodes of guinea pig No. 3 and pure cultures of *Staphylococcus aureus* were obtained. Their type was not determined.

SOURCE OF INFECTION

There is some evidence that involvement of lymph nodes may result from primary infections in skin injuries. There were three instances in which the presence of sub-cutaneous abscesses was associated with affected nodes. In one of these (No. 4896, Table 1) there was a multiple-head abscess on the left hind foot. An axillary node on the left side and two mandibular nodes were enlarged and necrotic. Apparently the lymph infection had ascended from the infected foot. The appearance at autopsy was similar in all respects to the usual combination of infected mandibular and axillary nodes. The question as to why the other cases of lymphadenitis were free from skin infections may, perhaps, be answered in two ways. First, the disease gives every evidence of being chronic, and probably of fairly long duration in the lymph nodes. Hence it would seem likely that in many cases the primary focus of infection may have become obscured by healing, thus leaving the deeper and more recently affected lymph nodes the only visible pathology at the time of autopsy. Second, there is the possibility of staphylococcal invasion of an epithelial injury without extensive reaction at that point. After a brief period

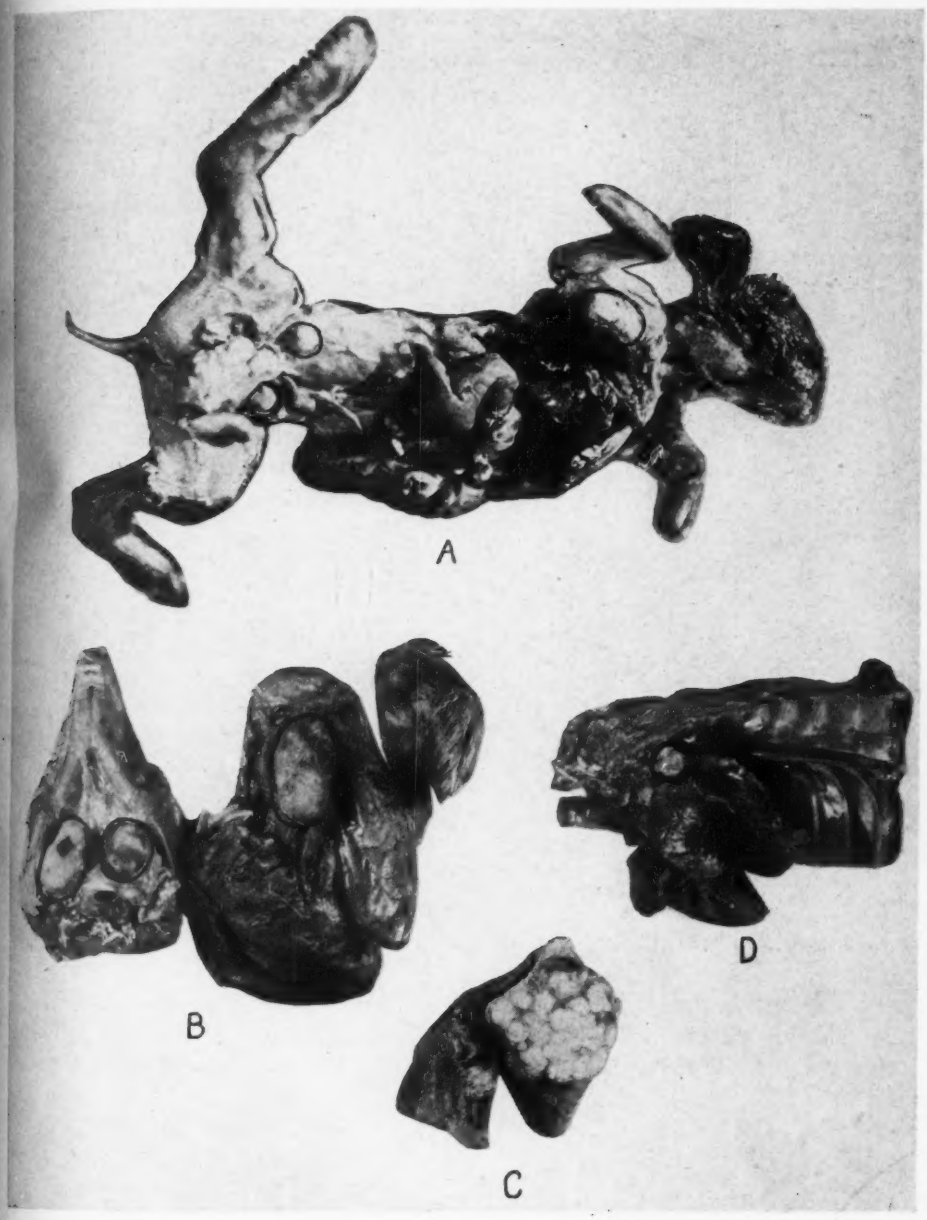
TABLE 1

DISTRIBUTION OF LYMPHADENITIS LESIONS IN COTTONTAILS[1]

M. Mandibular; A. Axillary; I. Inguinal; L. Lumbar; B. Bronchial; Sp. Spleen; H. Heart; K. Kidney; Lu. Lung; S.A. Sub-cutaneous abscess

Lab. No.	Date Coll.	County	Township	Sex	Lymph Nodes					Sp.	H.	K.	Lu.	S.A.	Remarks
					M.	A.	I.	L.	B.						
3695	11- 4-37	Oswego	Scriba	F		×	×			×		×			Record from Dr. E. K. Le Dune
3766	11-28-37	Franklin	Constable	M	×				×	×					Record from Dr. E. K. Le Dune
4485	1-24-39	Chautauqua	Ellicott	M	×	×				×					Bilateral involvement of nodes
4608	1-31-39	Franklin	Moriah	F										×	Thoracic, over long back muscles
4624	1-17-39	Cayuga	Conquest	M										×	Right side from scapula to lumbar region
4631	2-18-39	Chautauqua	Ellicott	M	×			×		×			×	×	Two sub-cutaneous abscesses, one at flank, one over rump
4718	2-13-39	Chautauqua	Ellicott	M	×										One node affected
4719	2-17-39	Chautauqua	Ellicott	M		×	×								Right side only
4746	2-24-39	Chautauqua	Ellicott	F	×					×					One node affected; spleen swollen, not necrotic
4748	2-23-39	Chautauqua	Ellicott	F	×	×									Left axillaries; both mandibulars
4785	3- 9-39	Chautauqua	Ellicott	F				×							Bruise and inflammation over sacral region
4792	3- 8-39	Chautauqua	Ellicott	F		×									Right side
4796	3- 8-39	Cortland	Virgil	M										×	Leg skinned at knee; abscess at injury
4799	2-25-39	Chautauqua	Ellicott	M		×									Right side
4802	2-26-39	Chautauqua	Ellicott	F	×	×									Left axillaries; left mandibular
4807	3-10-39	Chautauqua	Ellicott	M	×										Located on right external jugular
4815	3-10-39	Chautauqua	Ellicott	F							×				Necrotic masses in auricular half and apex of pericardial sac
4875	3-15-39	Chautauqua	Ellicott	F	×				×		×				Lesion in myocardium
4876	3-19-39	Chautauqua	Ellicott	F	×	×									Axillary enlarged without necrosis
4896	3-22-39	Wayne	Wolcott	M	×	×								×	Nodes on left side. Multiple abscess on sole of left forefoot
4918	3-27-39	Wayne	Wolcott	F										×	Median side of left hind leg and anteriorly about 6 in. on abdomen, latero-ventrally
4929	3-24-39	Wayne	Wolcott	M										×	At knee. Lymph node affected on median side
4961	3-24-39	Wayne	Wolcott	M							×				Healed lesion in myocardium
5060	4- 8-39	Wayne	Wolcott	M										×	Two, one between shoulders, one at small of back
5100	4- 2-39	Wayne	Wolcott	M	×										One node
5122	3-31-39	Wayne	Wolcott	M										×	Just beginning at point of right scapular
5125	4- 3-39	Wayne	Wolcott	F							×				Healed lesion in myocardium
5127	3-31-39	Wayne	Wolcott	F	×										One node
5335	6-17-39	Wayne	Sodus	M										×	On sole of left forefoot
5672	7-28-39	Steuben	Urbana	M	×									×	Pus pocket at base of tail; one node
7423	7-22-39	Onondaga	Lysander	M	×	×									Left side
Totals					31	15	10	2	2	2	5	4	1	1	11	

5335	6-17-39	Wayne	Galen	M	×										×	Pus pocket at base of tail, one hole
5672	7-28-39	Steuben	Urbana	M	×	×										Left side
7423	7-22-39	Onondaga	Lysander	M	×											
Totals					31	15	10	2	2	2	5	4	1	1	11	



A. Cottontail carcass showing one enlarged, necrotic axillary, and two lumbar, nodes.
B. Ventral view of head and left foreleg (No. 4896) showing necrotic axillary, and two mandibular, nodes.
C. Thoracic cavity with one necrotic bronchial node.
D. Heart with large necrotic mass on auricular region.

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of development the organisms may invade the lymph stream and reach the lymph nodes where they multiply and produce the characteristic swelling and necrosis.

EFFECTS OF THE DISEASE

No rabbits have been found dead or dying from this disease. There is no evidence of loss of weight; on the contrary, the weights of affected rabbits, perhaps by mere coincidence, tended to be greater. Fourteen (6 males, 8 females), from Ellicott Township averaged 1,205 grams, whereas uninfected rabbits (36 males, 34 females) from the same locality averaged 1,167.5 grams in weight. The appetites of affected rabbits seemed to be unimpaired, specimens which had been shot having normally full stomachs and intestines. The collectors noted no unusual behavior on the part of any of the animals. However, it seems likely that when the axillary lymph nodes are enlarged to the size of hen's eggs (as was the case of No. 4485, Table 1) there would be some lameness in the forelegs.

In addition to the evidence of field and laboratory observations, the inoculation experiments failed to indicate lymphadenitis as a fatal affection. However the third guinea pig inoculated developed extensive nodular necrosis and was etherized for autopsy five days after inoculation. The pathology was almost identical with that of the rabbits. Possibly this guinea pig might have succumbed to the infection had the disease run its course. Guinea pig No. 4 developed an abscessed inguinal node near the point of injection but made a complete recovery within 5 weeks. So far as the evidence goes, lymphadenitis is not fatal to cottontails, although those cases in which the infection metastasizes to the vital capillary organs may prove deadly; that development was shown to be fatal in snowshoe hares (MacLulich, 1937). Moribund rabbits may be hard for the collector to find; their true incidence may, therefore, escape notice.

DISCUSSION

There have been numerous references in the literature to abscesses, pus-pockets, and infected lymph nodes found in hares and cottontails. Seton (1909) recorded losses of hares and rabbits on his estate at Cos Cob, Conn. One of these hares examined by Dr. Seelye Little, was reported to have died of "a septicaemia due to infection by the staphylococcus *Pyogenes aureus*." This rabbit apparently had skin sores and infected lymph nodes, but unaffected capillary organs. MacLulich (1937) described frequent incidence of staphylococcal infections among hares and cottontails in Ontario. A fatal case in a varying hare was annotated in part as follows: "Almost all the important lymph nodes in the body were enlarged and had undergone cheesy degeneration. The lungs contained many pus-pockets and the pericardial cavity was filled with nodules containing pus; the heart muscle itself was degenerated and riddled with pus-pockets. Cultures . . . gave *Staphylococcus aureus* only." He reported guinea pigs as refractory, and a domestic rabbit as susceptible, to inoculations with material from this hare. In studying the strain isolated, Dr. C. E. Dolman of the Connought Laboratories found it to be low in toxin production. He and Dr. J. S. Kitching

also measured the antitoxin production of nine hares including the fatally affected one; all had less than one-tenth of one standard unit per c.c. MacLulich made this interesting observation, "The fact that varying hares have almost no antitoxin wherewith to neutralize staphylococcus toxin goes far toward explaining the frequent infections and the inability to overcome them. Even open skin abscesses have not healed in the cases that have been watched, some of them for three months." Measurement of staphylococcus antitoxin production in cottontails might aid in evaluating the resistance of this species to metastasis of a localized infection. The results of such study would permit a better, although theoretical, determination of the ultimate course of chronic infection.

J. Frederick Bell (1940, personal communication) reported rather frequent instances of staphylococcal infections among cottontails in Pennsylvania and described lesions very similar to those here noted. He suggested the possibility that the tick (*Ixodes dentatus*) may play an important part in increasing incidence of infection by opening the way through injuries to the skin or possibly by direct transmission. To date we have found no relationship between the occurrence of ticks and of lymphadenitis, but as previously pointed out, the disease is apparently chronic and although ticks are not present during the season of greatest incidence of the lymph infection, namely during late winter and early spring months, they may have attacked some of the diseased individuals during the preceding summer and fall. The epithelial lesions at points of tick attachment evidently disappear during the winter, thus obscuring their connection, if any, with lymphadenitis. Bell's suggestion would seem to deserve further investigation.

SUMMARY

An infection of the lymph system of cottontail rabbits is described and the distribution of necrotic foci is recorded. The causative organism was identified as a strain of *Staphylococcus aureus*. The avenue of infection is probably through skin injuries. Field and laboratory experience does not indicate intrinsic fatality of the lymphadenitis, although possible inaccessibility of the more gravely affected rabbits may prevent accurate evaluation of its importance as a factor in losses in the wild.

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THE TOXICITY OF CROTALARIA SPECTABILIS SEEDS FOR QUAIL[1]

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Crotalaria as a cover crop is gaining attention in our country's conservation program. This genus of the legume or pulse family consists of more than 600 species. Of this number at least six are known to be very toxic to cattle, sheep, and horses, namely, *C. sagittalis, C. juncea, C. burkeana, C. dura, C. globifera,* and *C. spectabilis.* Two other species, *C. striata* and *C. incana,* have been found poisonous in other countries but not in the United States (1 and 4). In 1935 the toxic agent of *Crotalaria spectabilis* was isolated by Neal, Rusoff, and Ahmann (4) and named "monocrotaline." This poison is an alkaloid that melts at 196–197°, and has an empirical formula of $C_{16}H_{26}O_6N$.

A very careful study was made by Thomas (5) on the toxicity of various species of *Crotalaria* seeds when fed to chickens, turkeys, quail, and doves. He found that the seeds of *Crotalaria spectabilis* are toxic for chickens, quail, and doves when fed or eaten in considerable quantities, but apparently not for turkeys. Quail force-fed 20 seeds showed no symptoms or lesions of poisoning; those force-fed 40 seeds became sick but showed no lesions; those force-fed 80–160 seeds died in 1 to 3 days and showed typical lesions. Birds of the same species, however, would not eat *C. spectabilis* seeds placed before them with their regular feed; neither did they eat the seeds in the field. The symptoms of poisoning in the force-fed quail were ruffled feathers, droopiness, and sometimes diarrhea. Autopsies revealed dark brown livers, occasionally with pale streaks, urates in kidneys and ureters, and *Crotalaria* seeds in the crops and gizzards. Also, there was a marked odor like that of crushed *Crotalaria* leaves emanating from the crops and gizzards. The seeds of *C. striata, C. grantiana, C. incana,* and *C. intermedia,* were not toxic to quail when force-fed in 5- and 10-gram doses.

Later, Emmel (3) contributed more light on the subject by his investigations of *Crotalaria* poisoning in the domestic fowl. He noted that the intestines may show slight catarrhal inflammation and usually are congested.

The Cooperative Quail Study Association (2) in a discussion of the toxicity of the crotalarias, points out that "the seed of the toxic species continue to be shunned by quail, though they have been used and experimented with intensively on Sherwood [Plantation] for several years, and at present appear to be safe to use with upland game." The Association states that crotalarias when used as cover crops help to improve markedly such later growing quail foods as bullgrass (*Paspalum boscianum*), Florida beggarweed (*Meibomia purpurea*), and sesbania (*Sesbania macrocarpa*). *Crotalaris spectabilis,* how-

[1] This article is based on information obtained from investigations carried on jointly by the Fish and Wildlife Service, U. S. Department of Interior and the Bureau of Animal Industry, U. S. Department of Agriculture, under funds provided by the Bankhead-Jones Act.

ever, has a tendency to get out of control on certain sandy loam soils and to spread into sections where it is not wanted. Therefore crotalarias can be used with safety on quail preserves only "if adequate *precautions are taken to prevent the poisoning of valuable livestock*, and to *confine the plants to the fields where grown.*"

Out of 3,669 crop analyses of bobwhites, that are recorded in the files of the Food Habits Section of the Fish and Wildlife Service (unpublished data), 108 revealed *Crotalaria* seeds. However, in only one case were seeds of a species known to be toxic identified. In that particular crop there were three seeds of *C. sagittalis* that composed a minute percentage of the contents. Not a single seed of *C. spectabilis* was identified from all the 108 crops mentioned.

EXPERIMENTAL PROCEDURE AND RESULTS

There seems to be sufficient evidence that *C. spectabilis* seeds are poisonous to quail when force-fed but the birds ordinarily will not eat them. However, the question has arisen whether quail will eat *C. spectabilis* when there is no choice of feeds. During the spring of 1940 several small tests were conducted at the Patuxent Research Refuge, Bowie, Maryland, to obtain an answer to this question. Six case-studies are here reported.

In three force-feeding was used in order to give the authors opportunity to study the symptoms of *Crotalaria* poisoning. In each of these experiments the birds were held in a battery compartment $22\frac{1}{2}'' \times 35'' \times 9\frac{1}{2}''$ high. In cases 1 and 2 the birds were fasted twenty-four hours before they were force-fed; in case 3 the bird was fed the *Crotalaria* seeds without a previous fasting period. Fresh water was supplied the birds from the start. The feeding device used was made from a piece of glass tubing 2.5 dm. long with an opening 5 mm. in diameter, and with an iron plunger so bent at the upper end that the lower end was stopped 2 mm. from the bottom of the glass tube. This tube was inserted very carefully through the mouth into the crop.

Case No. 1: A female quail, after the fasting period, was force-fed three grams of whole *Crotalaria* seeds in the forenoon and two grams in the afternoon. (There were approximately 67 seeds in a gram.)

On the following day she appeared well and was as active as at the start of the test. Approximately 130 whole seeds were found in her droppings, 80 apparently from one movement. Many of these excreted seeds were soft and swollen, but the majority were still quite hard. An additional three grams were fed in the morning, and three grams in the afternoon. Grit was supplied.

On the third day of the feeding, the bird was still active and apparently in good health. More seeds had been deposited in the droppings. Three grams of *Crotalaria* were fed in the morning, and only one in the afternoon.

The quail was still active on the fourth day. A normal breeding diet was placed before the birds and no more *Crotalaria* seeds were fed.

On the fifth day the bird was still active and, to all appearance, in normal condition. However, death came on the sixth day. A postmortem revealed no lesions or gas. The crop contained a

semi-liquid mixture of ground food material and whole *Crotalaria* seeds. Also the gizzard and the first eight inches of the small intestine contained this partially digested mixture.

Table 1 gives the weights of this bird day by day:

TABLE 1

LIVE WEIGHTS IN GRAMS: CASE NO. 1

Before fast period	*End of fast period First day of feeding*	*2nd day*	*3rd day*	*4th day*	*6th day*
180	170	159	159	163	147 (died shortly afterward)

Case No. 2: A male quail, weighing 173 grams, was fasted for 24 hours. At the end of the fast period, the weight was 162 grams. Two grams of whole *Crotalaria* seeds were force-fed.

On the following day the bird was found dead. The crop and gizzard contained *Crotalaria* seeds but the intestines were empty. There was some inflammation of the large intestine but the rest of the viscera appeared normal.

Case No. 3: A male quail weighing 179 grams, was force-fed 2 grams of ground *Crotalaria* seeds in the morning without preliminary fasting.

On the second day the bird appeared to be in normal condition. Two more grams of ground *Crotalaria* were force-fed in the morning.

The bird was as active as ever on the third day. A normal breeding diet was placed before him, and no more *Crotalaria* was administered.

On the fourth day the bird looked weak. The wings drooped and flying was difficult. In the afternoon the bird laid on his back, and was unable to rise. There were violent convulsions at intervals. Death came by the middle of the afternoon. The crop and gizzard contained feed and had a strong characteristic *Crotalaria* odor. There was much gas in the crop. The intestines were empty and hemorrhagic. The other viscera appeared to be normal.

Cases four, five, and six did not involve force-feeding. The birds were kept in the same type of battery compartment as was used in the first three tests.

Case No. 4: A wild male bird captured in the experimental quail enclosure was fed a breeding mash three days before being given *Crotalaria* seeds. Feed consumption was normal. On the fourth day whole *Crotalaria* seeds replaced the mash. The bird's weight at the time of the change of feed was 174 grams. During the following six days the bird was active and apparently in good health but it would eat very little of the *Crotalaria*. At the end of this period only 0.7 of a gram or approximately 46 seeds had been consumed. The bird's weight dropped to 106 grams. The *Crotalaria* seeds were replaced by the breeding mash.

On the day following the change of feed the bird died. A postmortem revealed hemorrhagic duodenitis with mild anemia. No *Crotalaria* seeds were present. Death probably resulted from inanition.

Case No. 5: A male and a female quail were fasted for 24 hours and then given a mash containing the following ingredients:

	Parts, by weight
Ground C. spectabilis seed	50.0
Ground yellow corn	17.0
Ground wheat	8.5
Ground kafir	8.5
Ground oat groats	8.5
Ground soybeans	6.5
Alfalfa leaf meal	1.0
Fortified cod-liver oil	0.5
Total	100.5

For the next five days the birds were active and apparently in normal condition. There were few droppings, and those that were excreted were very watery. Many passages of urine without admixture with feces were found.

On the following day the male died. Its crop and gizzard were full of feed, but the intestines, except the ceca, were empty and inflamed. The remainder of the viscera appeared normal. Only 18 grams of mash or an average of 3 grams for both birds per day had been eaten since the first feeding.

The surviving bird was given a choice of the feed containing *Crotalaria* and one that contained no *Crotalaria* but which was the same as the first in all other respects. During the week that followed, 147 grams of the feed without *Crotalaria* was consumed in comparison with only 2 grams of the diet containing *Crotalaria*. The feed without *Crotalaria* was removed.

During the next four days no feed was eaten. The test was closed and the bird was placed on a normal diet again.

The live weights of the birds in this case are given in Table 2.

Case No. 6: A pair of bob-whites was given a mixture of one part of *Crotalaria* and one part of oat groats in a feeder. Grit also was kept before the birds.

During the following 24 hours only 8 grams of the mixture had been eaten by both birds although normal food consumption for adults is about 15 grams per day. Undigested *Crotalaria* seeds appeared in the droppings, proving that at least one of the birds had eaten some of this food. The male appeared to be in good condition, but the female seemed weak. On the following day the female laid an egg, but was becoming weaker. On the third day the female could not fly but the male was still normal. Twelve grams of feed had been eaten during the previous 48 hours, or an average of 3 grams per bird per day. A normal grain mixture was placed before the birds in addition to the *Crotalaria* mixture.

During the fourth and fifth days 10 grams of the normal grain mixture were eaten to 3 grams of the *Crotalaria* mixture. However, on the following two days, only 9 grams of the former were eaten to 50 grams of the latter. The droppings had a vile odor not like that of normal excrement. Inasmuch as there

TABLE 2

LIVE WEIGHTS IN GRAMS OF BIRDS IN CASE NO. 5

Sex	Crotalaria feed alone		Choice of crotalaria feed and feed without crotalaria		Crotalaria feed alone	
	May 2	May 8	May 9	May 16	May 19	May 20
Male	143	71 (died)				
Female	174	143	129	130	115	101

was indication that the birds were picking out the oat groats from the *Crotalaria* mixture and apparently leaving the *Crotalaria* alone, the mixture was replaced by plain *Crotalaria*.

During the twenty-four hours following this change, only the normal grain mixture was eaten. The birds were then killed. A postmortem of the male revealed a normal condition of the viscera. The gizzard and intestines were filled, but there was no evidence of *Crotalaria* having been eaten. On the other hand, the intestines of the female were empty and slightly hemorrhagic. The gizzard contained 38 seeds of *Crotalaria* in addition to grains. A strong *Crotalaria* odor was perceptible.

TABLE 3

WEIGHTS IN GRAMS OF BIRDS IN CASE NO. 6

Sex	*June 11*	*June 12*	*June 14*	*June 15*	*June 16*	*June 18*	*June 19*	*June 20*
Male	177	173	169	165	164	167	171	166
Female	193	189	157	155	149	146	145	141

DISCUSSION

In cases 1, 2, and 3 in which the birds were force-fed there was no evidence of impaction as a result of the method of feeding. In all three cases death apparently was the result of acute poisoning. Although the bird in Case 1 received twice as many seeds in one day as the maximum dose fed by Thomas (5), it lived for more than 120 hours and was active until death. During the night following the first feeding it excreted two-fifths of the seeds undigested. It will be noted in Case 6 also that *Crotalaria* seeds were voided undigested.

SUMMARY AND CONCLUSIONS

The seeds of *Crotalaria spectabilis* are poisonous to bob-whites. Under ordinary conditions, however, they are not eaten by the birds when there is a choice of feeding stuffs. In fact some individuals starve rather than eat the toxic material.

If a few seeds of *C. spectabilis* are picked up accidentally, or otherwise, by the quail, there is a good possibility that they will be evacuated from the bowels undigested, and so do little harm.

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WHITE-TAILED DEER FOODS OF THE UNITED STATES[1]

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This list includes the names of plants, wild and cultivated, that have been recorded as being eaten by white-tailed deer. The compilation is from both published and unpublished material. Foods of the following sub-species are included in the list: *Odocoileus v. virginianus, O. v. borealis, O. v. macrourus,* and *O. couesi.*

Nothing appears to have been published about foods of the remaining white-tail sub-species. No attempt has been made to segregate the foods of the different sub-species of white-tail, because on considerable portions of the range two sub-species and crosses thereof occur together. Intensive food studies by the author in Missouri, on range in which this condition exists revealed that all of the animals were eating the same foods. A similar situation was also found in the Pisgah National Game Preserve by Ruff, and no doubt exists elsewhere.

It has been my experience that more variation in the foods taken by a single sub-species of white-tail occurs in different parts of the general range of the race than between the diets of two or more forms in the same locality. As a guide to management, it is important to learn food preferences of the deer on any particular area, but whether one race or more is involved, the food management problem will be the same.

The desirability of listing the part of each plant eaten was considered. However, it was found that many publications, particularly the earlier ones, did not supply this information. It may be obtained for some areas by referring to source publications indicated by reference numbers following the scientific names.

The feasibility of including data on palatability also was considered, but the same difficulty arose. Most authors have not recorded palatability. However, since species that are most palatable are likely to be discovered before the less palatable, it follows that the general palatability of a species within the white-tail range, will be indicated by the relative number of times it has been recorded. This may be learned from the reference citations listed in connection with the various food plants. Information on the foods for any particular part of the range can be obtained by referring to the publications indicated by the numbers within circles on the map (Figure 1). It should be borne in mind, however, that detailed information on palatability for any particular range can only be obtained by intensive local study.

The botanical nomenclature of the seventh edition of Gray's Manual has been used for those species found within its area. Names in accord with the international rules of nomenclature have been used for plants within Gray's area but not included in the manual. For the remaining species, chiefly western and southwestern, the nomenclature is that of "Range Plant Handbook," U. S.

[1] Revision of a manuscript originally prepared by the author while doing graduate work in the Division of Wildlife Management, University of Wisconsin.

Department of Agriculture, "Important Western Browse Plants" by W. A. Dayton, U. S. Department of Agriculture, and "Flora of New Mexico" by Wooton and Standley. In general, the same system was followed in selecting common names.

The writer's isolation from reference libraries has prevented consultation of all of the important papers bearing on the food of white-tailed deer but he believes that the coverage has been sufficient to indicate the relative values of most of the food items.

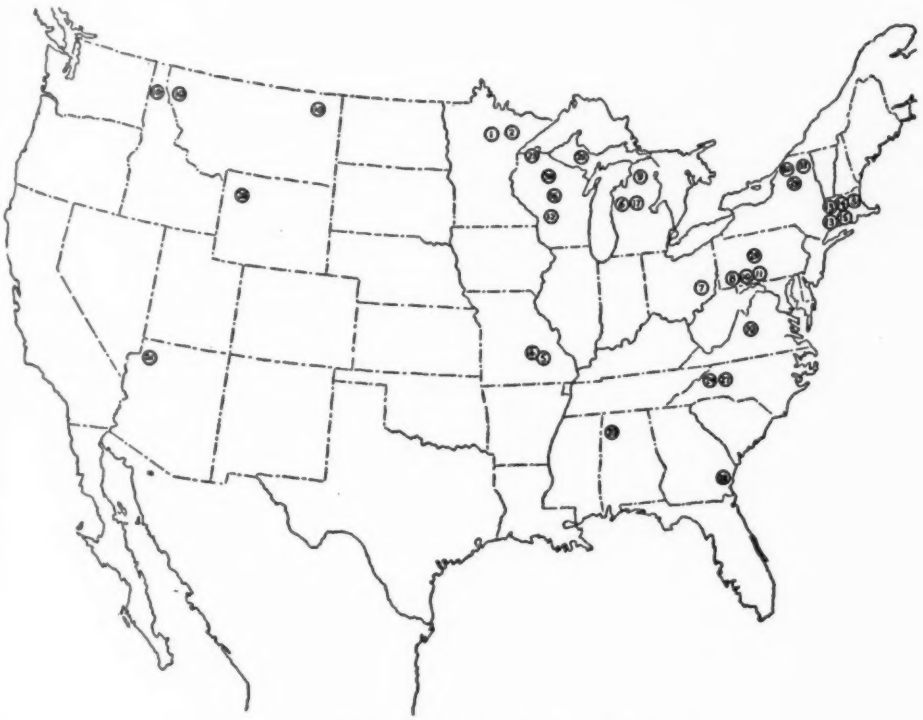

FIGURE 1. White-tailed deer food study areas.

WHITE-TAILED DEER FOODS OF THE UNITED STATES

Common Name	*Scientific Name*
	Non-flowering plants
Algae	Spirogyra 4, 5, 28
	Oedogonium 4, 5
	Vaucheria 4, 5, 14
Mushrooms	Panus stipticus 14
	Polyporus elegans 14
Other fungi	Daedalia confragosa 14
	Stereum rameale 14
	Scleroderma vulgare 14

Common Name	*Scientific Name*
	Non-flowering plants (Continued)
Square-hair moss	Alectoria fremonti 10
Green square-hair	A. sarmentosa 10
	Polypodiaceae (Ferns)
Rock polypody	Polypodium virginianum 14
Maidenhair fern	Adiantum pedatum 24
Cloak fern	Notholaena sp.
Brake, bracken	Pteris aquilina 12, 14, 21, 24, 28
Christmas fern	Polystichum acrostichoides 4, 5, 14, 24
Bay-scented fern	Dicksonia punctilobula 24
Margined shield fern	Aspidium marginale
Spinulose wood fern	A. spinulosum dilatatum 24
Spiny shield fern	A. spinulosum 14
New York fern	A. noveboracense 24
	Osmundaceae
Cinnamon fern	Osmunda cinnamomea 14, 24
Royal fern	O. regalis 24
	Ophioglossaceae
Moonwort	Botrychium 1, 2
	Equisetaceae
Horse tail	Equisetum arvense
	Lycopodiaceae (Club moss Family)
Club moss	Lycopodium obscurum 1, 2, 14
Club moss	L. complanatum 14
	Taxaceae
Ground hemlock, American yew	Taxus canadensis 8, 14, 17, 20
Yew	T. brevifolia 10
	Pinaceae (Pine Family)
White pine	Pinus strobus 1, 2, 8, 9, 12, 14, 17, 20, 24, 30
White pine	P. strobiformus 21
Pitch pine	P. rigida 8, 10a, 13, 14, 24
Pinon pine	P. edulis 21
Japanese red pine	P. densiflora 15
Jack pine	P. banksiana 1, 2, 8, 9, 10a, 12, 13, 14, 30
Shortleaf pine	P. echinata 8, 10a
Western yellow pine	P. ponderosa 10, 21
Lodgepole pine	P. contorta 10
Red pine, Norway pine	P. resinosa 1, 2, 8, 10a, 12, 13, 30
Limber pine	P. flexilis 10
Scotch pine	P. sylvestris 13
Austrian pine	P. nigra 8, 15
Tamarack	Larix laricina 8, 9, 12, 17, 22
European larch	L. decidua 15
Japanese larch	L. kaempferia 15
White spruce	Picea canadensis 8, 9, 17
Norway spruce	P. abies 8, 10a, 13

Common Name	*Scientific Name*
	Pinaceae **(Continued)**
Red spruce	P. rubra 8, 20, 22, 24
Englemann spruce	P. englemanni 10, 26
Colorado blue spruce	P. parryana 8
Black spruce	P. mariana 8
Balsam fir	Abies balsamea 1, 2, 8, 9, 17, 20, 22, 30
Alpine fir	A. lasiocarpa 10
Eastern hemlock	Tsuga canadensis 8, 10a, 11, 13, 14, 17, 20, 22, 24, 27
Hemlock	T. heterophylla 10
Douglas fir	Pseudotsuga taxifolia 8, 10, 13, 21
Coast white cedar	Chamaecyparis thyoides 15
White cedar	Thuja occidentalis 1, 2, 9, 17, 20, 30
Oriental arbor vitae	T. orientalis 15
Giant arbor vitae	T. plicata 10, 15
Pasture juniper	Juniperus communis 8, 10, 14, 17, 20
Dwarf juniper	J. sabina 10
Horizontal juniper	J. horizontalis 17
Rocky Mountain red cedar	J. scopulorum 10
Red cedar	J. virginiana 8, 13, 14, 20
Alligator bark juniper	J. pachyphloea 21
	Gramineae **(Grass Family)**
Broad leaf uniola	Uniola latifolia 23
Rescue grass	Bromus catharticus 21
Orchard grass	Dactylis glomerata 7, 24
Kentucky blue grass	Poa pratensis 4, 5, 7, 12
Wheeler blue grass	P. nervosa 10
Blue grass	P. fendleriana 21
Broom sedge	Andropogon virginicus 24
Slim triodia	Triodia mutica 21
Squirrel-tail	Sitanion hystrix 21
Grass	Muhlenbergia schreberi 4, 5
Timothy	Phleum pratense 7, 10, 24
Alpine timothy	Phleum alpinum 10
Side-oats grama	Bouteloua curtipendula 21
Crowfoot grama	B. rothrockii 21
Cotton grass	Trichachne californica 21
Corn	Zea mays 7, 12
Knot grass	Paspalum distichum 21
Quack grass	Agropyron repens 12
Oats	Avena sativa
Rye	Secale cereale 7
Bearded wheat grass	Agropyron caninum 10
Slender wheat grass	A. pauciflorum 10
Spreading wheat grass	A. scribneri 10
Bluestem	A. smithii 10
Blue wheat grass	A. spicatum 10
Redtop	Agrostis alba 10, 24
Downy chess	Bromus tectorum 10
Bluejoint	Calamagrostis canadensis 10
Pinegrass	C. rubescens 10

Common Name	*Scientific Name*
	Gramineae (Continued)
Timber oatgrass	Danthonia intermedia 10
Oatgrass	D. spicata 24
Tufted hairgrass	Deschampsia caespitosa 10
Canada wild-rye	Elymus canadensis 10
Bluebunch fescue	Festuca idahoensis 10
Rough fescue	F. scabrella 10
June grass	Koeleria cristata 10
Needle-and-thread	Stipa comata 10
Richardson needlegrass	S. richardsoni 10
Velvet grass	Nothoholcus lanatus 24
Johnson grass	Sorghum halepense 24
	Cyperaceae (Sedge Family)
Sedge	Carex umbellata 4, 5
Marsh sedge	Carex atrata 10
Douglas sedge	C. douglasii
Upland sedge	C. geyeri
	Araceae
Jack-in-the-pulpit	Arisaema triphyllum 24
	Eriocaulaceae
Pipewort	Eriocaulon articulatum
	Juncaceae
Rush	Juncus macer 4, 5
Rush	J. arizonicus 21
	Liliaceae (Lily Family)
False hellebore	Veratrum eschscholtzianum 10
Mariposa lily	Calochortus aureus 21
Fly poison	Amianthium muscaetoxicum 24
Indian cucumber root	Medeola virginiana 24
Common greenbrier	Smilax rotundifolia 24, 27
Saw brier	S. glauca 27
Greenbrier	S. bona-nox 5, 8
Bristly brier	S. hispida 5
Spanish bayonet	Yucca filamentosa 18
Clintonia	Clintonia umbellata 24
Canada mayflower	Maianthemum canadense 14
Small-flowered false hellebore	Veratrum parviflorum 24
False Solomon's-seal	Smilacina racemosa 24
	Amaryllidaceae
Mescal	Agave palmeri 21
	Iridaceae
Crested iris	Iris cristata 24
	Dioscoreaceae
Yamroot	Dioscorea glauca 4, 5, 24, 27
Ozark wild yam	D. quaternata 4, 5

Common Name	*Scientific Name*
	Salicaceae **(Willow Family)**
Black willow	Salix nigra 4, 5
Ward willow	S. wardi 4, 5
Sand-bar willow	S. longifolia 4, 5
Prairie willow	S. humilis 24
Dwarf gray willow	S. tristis 12
Bebb willow	S. bebbiana 22
Cottonwood	Populus fremonti 21
Cottonwood	P. angustifolia 10
American aspen	P. tremuloides 1, 2, 8, 9, 10, 11, 12, 17, 20, 22, 28
Aspen	P. aurea 21
Large-toothed aspen	P. grandidentata 8, 12, 17
Balsam poplar	P. balsamifera 1, 2, 17
Balm-of-Gilead	P. candicans 24
	Myricaceae
Sweet gale	Myrica gale 17, 22
Sweetfern	Myrica asplenifolia 8, 10a, 12, 24
	Juglandaceae **(Walnut Family)**
Black walnut	Juglans nigra 4, 5, 8
Butternut, white walnut	Juglans cinerea 4, 5, 8, 24
Walnut	Juglans major 21
Shagbark hickory	Carya ovata 4, 5
Pignut hickory	C. glabra 24
Mockernut hickory	C. alba 4, 5
Bitternut hickory	C. cordiformis 24
	Betulaceae **(Birch Family)**
Hazelnut	Corylus americana 4, 5, 7, 8, 12, 20
Beaked hazelnut	C. rostrata 1, 2, 24
Hazelnut	C. cornuta
Hophornbeam	Ostrya virginiana 1, 2, 4, 5, 8, 20
American hornbeam	Carpinus caroliniana 4, 5, 8, 20, 27
Black birch	Betula lenta 8, 20, 24, 27
Yellow birch	B. lutea 8, 9, 20, 22, 24, 27, 28
Resin birch	B. glandulosa 10
River birch	B. nigra 8
Red birch	B. fontinalis 10
Gray birch	B. populifolia 8, 22
Bog birch	B. pumilis var. glandulifera 12
Paper birch	B. alba var. papyrifera 1, 2, 8, 12, 17, 20
Smooth alder	Alnus rugosa 4, 5, 8, 24
Alder	A. crispa 16
Speckled alder	A. incana 9, 12, 14, 17, 20, 22
Alder	A. tenuifolia 10
	Fagaceae **(Beech Family)**
Beech	Fagus grandifolia 8, 20, 22, 24, 27, 28
Chestnut	Castanea dentata 10a, 24, 27
Chinquapin	C. pumila 8, 24
Emory oak, black oak	Quercus emoryi 21

Common Name	*Scientific Name*
	Fagaceae (Continued)
Gambel oak	Q. gambelii 21
White-leaf oak	Q. hypoleuca 21
Swamp white oak	Q. bicolor 15
Mexican white oak	Q. oblongifolia 21
White oak	Q. alba 4, 5, 8, 10a, 14, 24, 27
Black-jack oak	Q. marilandica 4, 5
Post oak	Q. stellata 4, 5
Bur oak	Q. macrocarpa 8
Chestnut oak	Q. montana 7, 24, 27
Chestnut oak	Q. prinus 8
Southern red oak	Q. rubra 24
Red oak	Q. borealis var. shumardii 1, 2, 4, 5, 8, 14, 17, 20, 24, 27
Red oak	Q. borealis var. maxima
Pin oak	Q. palustris 8
Scarlet oak	Q. coccinea 4, 5, 8, 10a, 24, 27
Yellow oak	Q. ellipsoidalis 16
Black oak	Q. velutina 4, 5, 8, 10a, 24, 27
Scrub oak	Q. nana
Scrub oak	Q. ilicifolia 8, 9, 10a
Arizona oak	Q. arizonica 21
	Urticaceae
Slippery elm	Ulmus fulva 4, 5
American elm	U. americana 1, 2, 8, 10a
Cork elm	U. racemosa 4, 5
Hackberry	Celtis occidentalis 8
Desert hackberry	C. pallida 21
Mountain hackberry	C. reticulata 21
Hemp	Cannabis sativa 12
Osage orange	Maclura pomifera 8
Mulberry	Morus alba 8
Mulberry	M. microphylla 21
Red mulberry	M. rubra 16
Wood nettle	Laportea canadensis 28
Pellitory	Parietaria obtusa 21
	Loranthaceae
Mistletoe	Phoradendron flavescens 21
Mistletoe	P. macrophyllum 21
Mistletoe	P. juniperinum 21
	Aristolochiaceae
Heartleaf	Asarum virginicum 24
	Polygonaceae (Buckwheat Family)
Sour dock	Rumex crispus 4, 5
Smooth dock	R. altissimus 4, 5
Swamp dock	R. verticillatus 4, 5
Broad-leaved dock	R. obtusifolius 4, 5
Sheep sorrel	R. acetosella 1, 4, 5, 14, 24
Ladysthumb	Polygonum pennsylvanicum 4, 5

Common Name	*Scientific Name*
	Polygonaceae (Continued)
Smartweed, water-pepper	P. hydropiper (punctatum) 4, 5, 24
Wild buckwheat	P. scandens 4, 5
Buckwheat brush	Erigonum wrightii 21
Buckwheat brush	E. abertianum 21
Buckwheat	Fagopyrum esculentum 3, 6, 12
	Chenopodiaceae
Chamiso	Atriplex canescens 21
Saltweed	A. wrightii 21
Goosefoot	Chenopodium album 7
Lambsquarters	C. fremonti 21
Lambsquarters	C. album 10
	Amaranthaceae
Pigweed, careless weed	Amaranthus palmeri 12, 14, 21
	Allionaceae
Boerhaavia	Boerhaavia 21
	Phytolaccaceae
Pokeweed	Phytolacca decandra 4, 5, 24
	Caryophyllaceae
Mouse-eared chickweed	Cerastium vulgatum var. hirsutum 4, 5
Mouse-eared chickweed	C. brachypodum 4, 5
Fire pink	Silene virginica 4, 5, 24
	Portulacaceae
Talinum	Talinum patens 21
Purslane	Portulaca lanceolata 21
	Nymphaeaceae
Yellow pondlily	Nymphaea advena 28
Sweet-scented waterlily	Castalia odorata 28
	Ranunculaceae
Buttercup, crowfoot	Ranunculus recurvatus 4, 5
Buttercup	R. glaberrimus 10
Meadow-rue	Thalictrum dasycarpum 4, 5
Meadow-rue	T. revolutum 4, 5
Anemone	Anemone tuberosa 21
Thimbleweed	A. virginiana 4, 5
Goldthread	Coptis groenlandica 14
Tall larkspur	Delphinium barbeyi 10
	Magnoliaceae
Cucumber tree	Magnolia acuminata 27
Ear-leaved umbrella tree	M. fraseri 24
Tulip-tree	Liriondendron tulipifera 8, 24, 27
	Calycanthaceae
Smooth sweetshrub	Calycanthus fertilis 24

Common Name	*Scientific Name*
	Berberidaceae
Oregon grape	Odostemon aquifolium 10
Creeping holly-grape	O. repens 10
	Lauraceae
Sassafras	Sassafras albidum 4, 5, 8, 24, 27
Spicebush	Benzoin aestivale 8, 24, 27
	Papaveraceae
Bloodroot	Sanguinaria canadensis 4, 5
Prickly poppy	Argemone intermedia (A. platyceras) 21
Poppy	Eschscholtzia parvula 21
	Cruciferae
Bladderpod	Lesquerella gordonii 21
Peppergrass	Lepidium lasiocarpus 21
Cabbage	Brassica oleracea 14, 24
Mustard	Sisymbrium irio 21
Water cress	Radicula nasturtium-aquaticum 4, 5
Rock cress	Arabis perennans 21
Lacepod	Thysanocarpus laciniatus 21
Streptanthus	Streptanthus arizonicus 21
	Saxifragaceae
False miterwort	Tiarella cordifolia 14
Alumroot	Heuchera hirsuticaulis 4, 5
Silver-leaf hydrangea	Hydrangea radiata 2, 4
Hydrangea	H. aborescens 24
Hydrangea	H. cinerea 5
Mock-orange	Philadelphus lewisii 10
Fendlera	Fendlera rupicola 21
Skunk currant	Ribes glandulosum 8, 22
Prickly gooseberry	R. cynosbati 24
	Hamamelidaceae
Ozark witch-hazel	Hamamelis vernalis 4, 5
Eastern witch-hazel	H. virginiana 4, 5, 8, 20, 24, 27
	Platanaceae
Sycamore	Platanus wrightii 21
Sycamore	P. occidentalis 8, 24
	Rosaceae (Rose Family)
Ninebark	Opulaster malvaceus 10
Ninebark	O. opulifolius
Meadow-sweet	Spiraea latifolia 17, 22
Hardhack	S. tomentosa 1, 2, 22
Apple	Pyrus malus pumila 3, 4, 5, 7, 8, 12, 14, 20, 24
Chokeberry	Pyrus melanocarpa 8, 12, 22
American mountain-ash	Pyrus americana 8, 20, 22
Juneberry	Amelanchier laevis
Serviceberry	A. canadensis 4, 5, 8, 17, 22, 24
Serviceberry	A. alnifolia 10

Common Name	*Scientific Name*
	Rosaceae (Continued)
Shadbush	A. humilis 12
Black hawthorn	Crataegus douglassi 10
Hawthorn, redhaw	Crataegus sp, 4, 5, 8, 20
Hawthorn	C. sheridana 10
Wild strawberry	Fragaria virginiana 14, 24
Wild strawberry	F. virginiana var. illinoensis 4, 5
Strawberry	F. sp. 25
Shrubby cinquefoil	Potentilla fruticosa 10, 17
Cinquefoil	P. canadensis 14, 24
Cinquefoil	P. canadensis var. simplex 4, 5
White avens	Geum canadense var. camporum 4, 5, 14
Wild red raspberry	Rubus idaeus var. aculeatissimus 17, 21, 22, 28
Black raspberry	R. occidentalis 4, 5, 24
Purple-flowering raspberry	R. odoratus 17
Blackberry	R. allegheniensis 4, 5, 7, 22, 24, 27
Dwarf raspberry	R. hispidus 14
Blackberry	R. ostryifolius 4, 5
Dewberry, creeping blackberry	R. flagellaris 4, 5
Thimbleberry	R. parviflorus 10
Dewberry	R. villosus 12, 24, 28
Agrimony	Agrimonia parviflora 24
Curled-leaf mahogany	Cercocarpus ledifolius 10
Mountain-mahogany	C. paucidentatus 21
Mountain-mahogany	C. montanus 10
Climbing rose	Rosa setigera var. tomentosa 4, 5
Wild rose	R. carolina 4, 5
Wild rose	R. subserrulata 4, 5
Wild rose	R. humilis 17
Sweetbriar	R. eglanteria 8
Cliffrose	Cowania stansburiana 21
Black chokecherry	Prunus melanocarpa 10
Chokecherry	Padus sp. 21
Western chokecherry	Prunus demissa 10
Black cherry	Prunus serotina 8, 12, 14, 22, 24
Bitter cherry	P. emarginata 10
Chokecherry	P. virginiana 8, 9, 20
Fire cherry	P. pennsylvanica 1, 2, 12, 22, 24, 28
Sand cherry	P. pumila 17
Wild plum	P. americana 12
Peach	P. persica 3, 19
Bitter brush	Purshia tridentata 10
	Leguminosae
Catclaw mimosa	Mimosa biuncifera 21
Catclaw	Acacia greggii 21
Mesquitillo	Calliandra eriophylla 21
Mesquitillo	C. humilis 21
Large-flowered partridge-pea	Cassia fasciculata 24
Small-flowered partridge-pea	C. nictitans 21
Mesquite	Prosopis juliflora 21

Common Name	*Scientific Name*
	Leguminosae (Continued)
Redbud	Cercis canadensis 5
Wild indigo	Baptisia tinctoria 24
Lupine	Lupinus 21
Red clover	Trifolium pratense 4, 5, 14, 24
White clover	Trifolium repens 4, 5, 24, 25
Low hop-clover	T. procumbens 4, 5
Yellow sweet-clover	Melilotus officinalis 4, 5
White sweet-clover	M. alba 4, 5
Alfalfa	Medicago sp 1, 26
Birdsfoot trefoil	Lotus mollis 21
Birdsfoot trefoil	L. wrightii 21
Indigo-bush	Amorpha fruticosa 24
False indigo	A. californica 21
Honey locust	Gleditsia triacanthos 5
Locust	Robinia neomexicana 21
Black locust	R. pseudoacacia 10a, 24, 27
Locoweed	Astragalus nothoxys 21
Tick trefoil	Desmodium nudiflorum 4, 5
Tick trefoil	D. grandiflorum 4, 5
Tick trefoil	D. canescens 4, 5
Tick trefoil	D. bracteosum 4, 5
Tick trefoil	D. laevigatum 4, 5
Tick trefoil	D. dillenii 4, 5
Tick trefoil	D. marilandicum 4, 5
Bushclover	Lespedeza procumbens 5
Wandstem bushclover	L. frutescens 24
Bushclover	L. repens 5, 24
Bushclover	L. hirta 24
Bushclover	L. violacea 5
Bushclover	L. virginica 5
Bushclover	L. striata 7, 24
Bushclover	L. intermedia 5
Hog peanut	Amphicarpa bracteata 4, 5
Hog peanut	A. monoica 24
Western coralbean, chilicote	Erythrina flabelliformis 21
False mesquite, kidneywood	Eysenhardtia orthocarpa (polystachya) 21
Little ratany, cosahui	Krameria parvifolia 21
Soybean	Soja max 6, 12
Wild pea	Lathyrus ochroleucus 10
Cow pea	Vigna sinensis 6
	Oxalidaceae
Wood sorrel	Oxalis corniculata 24
Wood sorrel	Oxalis sp 21
	Geraniaceae
Alfilaria	Erodium cicutarium 21
	Zygophyllaceae
Mexican poppy	Kallstroemia grandiflora 21

Common Name	*Scientific Name*
	Simarubaceae
Tree-of-heaven	Ailanthus glandulosa 8
	Euphorbiaceae
Doveweed	Croton capitatus 5
Doveweed	C. monanthogynus 5
Spurge	Euphorbia albomarginata 21
	Anacardiaceae
Staghorn sumac	Rhus typhina 12, 20
Smooth sumac	R. glabra 4, 5, 12
Dwarf sumac, winged sumac	R. copallina 4, 5, 7, 24
Poison ivy	R. toxicodendron 4, 5
Fragrant sumac	R. canadensis 4, 5
Lemonade sumac	R. canadensis var. trilobata 10, 21
	Aquilfoliaceae
Winterberry, black alder	Ilex verticillata 8, 12
American holly	I. opaca 24
Northern holly	Nemopanthus mucronata 12, 22
	Celastraceae
Wahoo	Evonymus atropurpureus 29
Bittersweet	Celastrus scandens 3, 8
Mountain-lover	Pachistima myrsinites 10
	Aceraceae
Striped maple, moosewood	Acer pennsylvanicum 8, 20, 22, 24, 27, 28
Mountain maple	A. spicatum 22
Mountain maple	A. glabrum 10
Sugar maple, hard maple	A. saccharum 4, 5, 8, 9, 14, 20, 22, 28
Silver maple	A. saccharinum 4, 5, 17
Red maple	A. rubrum 1, 2, 4, 5, 7, 8, 9, 10a, 12, 14, 20, 22, 24, 27, 28
Boxelder	A. negundo
	Sapindaceae
Buckeye	Aesculus octandra 24
	Balsaminaceae
Spotted touch-me-not, jewel-weed	Impatiens biflora 4, 5, 24
Pale jewel-weed	I. pallida 24
	Rhamnaceae
Snow bush	Ceanothus velutinus 10
New Jersey tea	C. americanus
Small-leaf ceanothus	C. sanguineus 10
Graythorn, whitethorn	Condalia lycioides 21
	Vitaceae
Virginia creeper	Psedera quinquefolia 4, 5, 8, 24, 27
Fox grape	Vitis labrusca 24
Summer grape	V. aestivalis 4, 5, 24
Grape	V. vulpina 16, 24
Grape	V. arizonica 21
Chicken grape	V. cordifolia 24

Common Name	*Scientific Name*
	Tiliaceae
Basswood	Tilia glabra 1, 2, 8, 20
White basswood	T. heterophylla 24, 27
	Malvaceae
Wild cotton	Gossypium thurberi 21
	Fouquiereaceae
Candlewood, ocotillo	Fouquieria splendens 21
	Hypericaceae
Spotted St. John's-wort	Hypericum punctatum 4, 5
St. Andrew's-grass	Ascyrum hypericoides 24
	Violaceae
Blue violet	Viola papilionacea 4, 5
Hairy violet	V. sororia 4, 5
	Loasaceae
Blazing-star	Mentzelia albicaulis 21
	Thymeleaceae
Leatherwood, moosewood	Dirca palustris 20
	Araliaceae
Wild sarsaparilla	Aralia nudicaulis 28
Elk-clover	A. bicrenata 21
	Elaeagnaceae
Buffaloberry	Shepherdia canadensis 17
Russet buffaloberry	Lepargyraea canadensis 10
Silverberry	Elaeagnus commutata 10
	Onagraceae
Evening primrose	Oenothera 21
Fireweed	Chamaenirion angustifolium 10
	Umbelliferae
Wild angelica	Spermolepis echinata 21
Wild angelica	Angelica curtisii 24
Carrot	Daucus carota 24, 25
	Cornaceae
Flowering dogwood	Cornus florida 4, 5, 7, 24, 27
Red-osier dogwood	C. stolonifera 1, 9, 10, 12, 17, 20, 30
Gray dogwood	C. racemosa 5
Dogwood	C. paniculata (femina) 12, 16
Dogwood	C. obliqua 12
Alternate-leaved dogwood	C. alternifolia 5
Bunchberry	C. canadensis 1, 2
Black gum	Nyssa sylvatica 4, 5, 7, 8, 19, 24, 27
Silktassel	Garrya wrightii 10

Common Name	*Scientific Name*
	Ericaceae
Mountain pepperbush	Clethra acuminata 24, 27
Pipsissewa	Chimaphila umbellata 10
Shinleaf	Pyrola elliptica 14
Labrador tea	Ledum groenlandicum 1, 2, 12, 17, 22
Flame-colored azalea	Rhododendron calendulaceum 24, 27
Piedmont azalea	R. canescens 24
Great laurel	R. maxima 8, 24
Alleghany menziesia	Menziesia pilosa 24
Madrona	Arbutus arizonica 21
Mountain laurel	Kalmia latifolia 7, 8, 10a, 14, 24, 27
Sheep laurel	K. angustifolia 8, 14
Fetterbush, doghobble	Leucothoë catesbaei 24, 27
Fetterbush	L. recurva 27
Mountain fetterbush	Andromeda floribunda 24
Leatherleaf	Chamaedaphne calyculata 1, 2, 12, 22
Sorrel tree, sourwood	Oxydendrum arboreum 7, 19, 23, 24, 27
Arbutus	Epigaea repens 8, 14, 24
Wintergreen	Gaultheria procumbens 1, 2, 12
Bearberry	Arctostaphylos urva-ursi 10, 17
Manzanita	A. pungens 21
Black huckleberry	Gaylussacia baccata 24, 27
Farkleberry	Vaccinium arboreum 23
Deerberry	V. stamineum 4, 5, 8, 27
Deerberry	V. stamineum var. neglectum 4, 5
Tall huckleberry	V. membranaceum 10
Southern blueberry	V. melanocarpum 27
Low sweet blueberry	V. pennsylvanicum 12, 24
Sour-top blueberry	V. canadense 22
Low-bush huckleberry	V. vacillans var. crinitum 4, 5
Small huckleberry	V. scoparium 10
High-bush huckleberry, swamp blueberry	V. corymbosum 27
	Diapensiaceae
Galax	Galax aphylla 24
	Primulaceae
Water pimpernel	Samolus floribundus 4, 5
Four-leaved loosestrife	Lysimachia quadrifolia 1, 24
	Ebenaceae
Persimmon	Diospyros virginiana 4, 5, 24
	Styracaceae
Sweetleaf, horsesugar	Symplocos tinctoria 24, 27
Silverbell	Halesia carolina 24, 27
	Oleaceae
White ash	Fraxinus americana 4, 5, 8, 13, 24
Red ash	F. pennsylvanica 8
Green ash	F. pennsylvanica var. lanceolata 4, 5, 8

Common Name	*Scientific Name*
	Oleaceae (Continued)
Black ash	F. nigra 8, 9, 20
Arizona ash	F. velutina 21
Lilac	Syringa vulgaris 12
	Loganiaceae
Yellow jasmine	Gelsemium sempervirens 23
	Apocynaceae
Dogbane	Apocynum androsaemifolium 10
Butterflyweed	Asclepias tuberosa 24
	Convolvulaceae
Morning-glory	Evolvulus linifolius 21
Wild sweet potato, man-of-the-earth	Ipomoea pandurata var. pubescens 4, 5
Morning-glory	I. barbatisepala 21
Morning-glory	I. cordifolia 21
	Polemoniaceae
Phlox, sweet-william	Phlox pilosa var. virens 4, 5
Golden gilia	Gilia aurea 21
Gilia	G. candida 21
	Hydrophyllaceae
Phacelia	Phacelia alba 21
Phacelia	P. crenulata 21
	Acanthaceae
Tetramerium	Tetramerium hispidum
	Labiatae
White beebalm	Monarda clinopodia 24
Selfheal, healall	Prunella vulgaris var. lanceolata 4, 5, 24
Mountain mint	Pycnanthemum flexuosum 24
Mountain mint	P. montanum 24
Mountain mint	P. pycnanthemoides 24
Bluebell	Mertensia virginica 5
Burrcomb	Cryptanthe barbigera 21
Paintweed	Plagiobothrys arizonicus 21
Combseed	Pectocarya recurvata 21
Lyre-leaved sage	Salvia lyrata 24
	Solanaceae
White horse-nettle	Solanum elaeagnifolium 21
Bittersweet	S. dulcamara 16
Horse-nettle	S. carolinense 24
Ground-cherry	Physalis crassifolia 21
	Scrophulariaceae
Common mullein	Verbascum thapsus 17, 24
San Jose beard-tongue	Pentstemon wrightii 21
White turtlehead	Chelone glabra 24
Pink turtlehead	C. lyoni 24

Common Name	*Scientific Name*
	Scrophulariaceae (Continued)
Rose turtlehead	C. obliqua 24
Paintbrush	Castilleja austromontana 21
Paintbrush	C. angustifolia 10
Yellow false-foxglove	Aureolaria flava var. macrantha 4, 5
Early wood-betony	Pedicularis canadensis 24
	Bignoniaceae
Trumpet creeper, trumpet vine	Tecoma radicans 4, 5
Catalpa	Catalpa speciosa 8
Crossvine	Bignonia capreolata 23
Desert willow	Chilopsis linearis 21
	Acanthaceae
Wild-petunia	Ruellia pedunculata 4, 5
False-honeysuckle	Anisacanthus thurberi 21
	Plantaginaceae
Trigo	Plantago insularis 21
Common plantain	P. major 24
Rugel plantain	P. rugelii 4, 5
Ribgrass	P. lanceolata 14, 24
Plantain	P. virginica 4, 5
	Rubiaceae
Bouvardia	Bouvardia glaberrima 21
Goose-grass	Galium aparine 21
Shining bedstraw	G. concinnum 4, 5
Partridge-berry	Mitchella repens 14
	Caprifoliaceae
Southern mountain honeysuckle	Diervilla sessilifolia 24
Bush honeysuckle	D. lonicera 2
Honeysuckle	Lonicera canadensis 8, 17, 20
Swamp fly-honeysuckle	L. oblongifolia 22
Japanese honeysuckle	L. japonica 24
Coralberry	Symphoricarpos orbiculatus 4, 5
Twin-flower	Linnaea borealis var. americana 1, 2, 10
Blackhaw	Viburnum prunifolium 8
Blackhaw	V. rufidulum 23
Witch-hobble	V. alnifolium 14, 20, 22, 28
Wild raisin	V. cassinoides 14, 17, 20, 22, 24
Arrow-wood	V. acerifolium 16
Elder	Sambucus canadensis 8, 20, 24
Red-berried elder	S. racemosa 24, 28
	Cucurbitaceae
Wild balsam-apple	Echinocystis gilensis 21
	Campanulaceae
American bellflower	Campanula americana 4, 5
	Lobeliaceae
Blue lobelia	Lobelia siphilitica 4, 5

Common Name	*Scientific Name*
	Cichoriaceae
Nemoseris	Nemoseris neomexicana 21
	Compositae
Purple boneset	Eupatorium purpureum 24
White snakeroot	E. urticaefolium 24
Brickellia	Brickellia californica 21
Ironweed	Vernonia noveboracensis 24
Goldenrod	Solidago hispida 4, 5
Boot goldenrod	S. arguta var. bootii 4, 5
Field goldenrod, gray goldenrod	S. nemoralis 4, 5
Lanceleaf rabbit-brush	Chrysothamnus lanceolatus 10
Rabbit-brush	C. oreophilus 10
Wild aster	Aster anomalus 4, 5
Wild aster	A. macrophyllus 24
Wild aster	A. saggittifolius 4, 5
White wood-aster	A. divaricatus 24
Wild aster	A. laevis 4, 5
Wild aster	A. lateriflorus 4, 5
Timber aster	A. conspicuus 10
Balsamroot	Balsamorrhiza sagittata 10
Daisy fleabane	Erigeron philadelphicus 4, 5
Daisy fleabane	E. annuus 4, 5
Fleabane	E. commixtus 21
Horseweed	E. canadensis 12
Groundsel bush	Baccharis glutinosa 21
Groundsel bush	B. pteronioides 21
Pussytoes, ladies' tobacco,	Antennaria plantaginifolia 4, 5, 24
Sweet everlasting	Gnaphalium polycephalum 4, 5
Starry rosin-weed	Silphium asteriscus 4, 5
Giant ragweed	Ambrosia trifida 4, 5
Short ragweed	A. artemisiifolia 7, 12, 24
Bur-sage	Franseria tenuifolia 21
Black-eyed Susan	Rudbeckia hirta 4, 5, 24
Hairy wood-sunflower	Helianthus atrorubens 24
Common sunflower	H. annuus 12
Yellow ironweed	Actinomeris alternifolia 24
Gymnolomia	Gymnolomia annua 21
Golden-eye	Viguiera annua 21
Golden-eye	V. helianthoides 6, 21
Trefoil coreopsis	Coreopsis major 24
Brown-eyed Susan	Gaillardia aristata 10
Spanish-needles	Bidens bipinnata 5
Spanish-needles	B. heterophylla 21
Yarrow	Achillea millefolium 10, 24
Ox-eye daisy	Chrysanthemum leucanthemum var. pinnatifidum 4, 5, 24
Green sage	Artemisia discolor 10
Silver sage	A. frigida 10
Big sage	A. tridentata 10
Sage	A. mexicana 21

Common Name	*Scientific Name*
	Compositae (Continued)
Arnica	Arnica cordifolia 10
Bull thistle	Cirsium lanceolatum 24
Dandelion	Taraxacum palustre var. vulgare 4, 5
Sow thistle	Sonchus oleraceus 21
Lettuce	Lactuca sativa 25
Wild lettuce	L. canadensis 4, 5
Hawksbeard	Crepis acuminatum 10
Gall-of-the-earth	Prenanthes altissima 24
Hawkweed	Hieracium gronovii 4, 5
Microseris	Microseris linearifolia 21
Stephanomeria	Stephanomeria pauciflora 21
Golden groundsel	Senecio aureus 24
Ragwort	S. pauperculus 24

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TRENDS IN THE KILL OF WISCONSIN WHITETAIL BUCKS, 1936–1940

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From 1925 to 1936, Wisconsin had an alternate-year open season on bucks. Due to the increase in number of deer there has been yearly hunting since 1936. Table 1 based on reports from licensees to the Wisconsin Conservation Department shows the trend of the kill since 1936.

TABLE 1

Year	*Deer tags issued*	*Deer killed*
1936	97,735	29,676
1937	90,906	14,835
1938	103,721	32,855
1939	109,619	25,730
1940	105,056	33,138
1936–40	507,037	136,234

The duration of each season was seven days except in 1937 when it was three days. The low kill in 1939 was likely due to lack of snow during the hunting period.

In recent years many deer hunters have expressed the belief that Wisconsin whitetail bucks are gradually decreasing in weight, and that their antlers are becoming progressively smaller. The general belief is that increased hunting intensity, brought about by motor transportation and by consecutive seasons on bucks since 1935, has caused this decline. If this is true, then Wisconsin's deer are retrograding in quality at the same time that they are increasing in number.

[1] Acknowledgments are made to Edmond B. Siemers and William Lambert for help in getting measurements, the Wisconsin Conservation Department for furnishing information on seasons and kill returns, and Aldo Leopold for reading this manuscript.

Since 1935, we have measured the antlers of 452 whitetail bucks shot in 24 counties, and obtained weights of 108 of these deer. Measurements and weights were taken in the belief that comparisons of them from year to year would reveal whether deterioration is occurring.

All measurements were made with a steel caliper and a non-stretchable tape and included: (1) Diameter of beams about one half inch above burr, (2) diameter of burrs, (3) length of beams, (4) number of tines on each antler, and (5) greatest spread of antler beams. Dressed weights were obtained, verbally or by correspondence, from the hunters.

To make the comparisons valid, the method of selecting samples had to be the same for each year. Our measurements include all of the heads sent to two taxidermists in central and northern Wisconsin during each of the last five hunting seasons. We do not claim that the bucks measured represent a true cross section of each year's deer kill, as they probably tended to be the best. The comparison, therefore, is of the best kills of 1940 with those of 1936.

Weight

Table 2 gives the average dressed weight of 108 bucks. A progressive decrease is evident.

Johnson (1937, p. 477) found that the average weight of bucks killed on an area in Pennsylvania was 127 pounds, and on a second tract having two and one-half times more deer, only 92 pounds.

TABLE 2

DRESSED DEER WEIGHTS

Date	*Number of deer*	*Average weight*
1936	47	170
1937	14	169
1938	28	115
1939	10	147
1940	9	136
1936–40	108	160

Sanders (1941, p. 187) reported that the average weight of deer killed on shooting preserves in Texas decreased as the number increased.

Number of Tines

Table 3 shows how many deer were killed in each of 19 classes based on the total number of tines per head. The proportions killed in each class, for all five years, are very similar to those found by Cahalane (1931, p. 289) in Michigan.

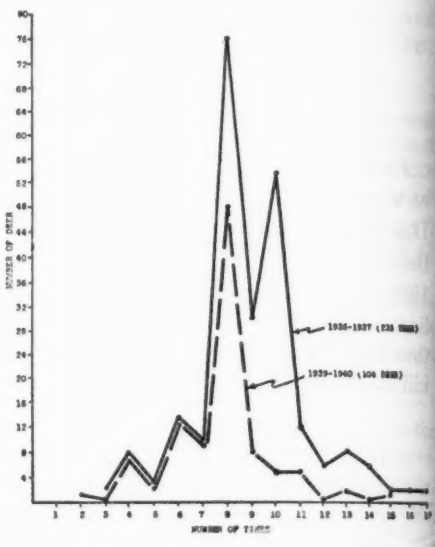

FIG. 1. Frequency of Antler Classes.

ing 1936 and 1937 to 8 tines per head in 1939 and 1940. Antlers of 12 or more

TABLE 3

NUMBER OF BUCKS CLASSED ON BASIS OF TOTAL TINES PER HEAD

Year	Number of tines																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18 or over
1936			1	3	2	10	8	60	22	46	7	4	5	4	1		2	1
1937			1	5	1	4	2	16	8	8	5	2	3	2	1	2		3
1938	2	2	1	9	6	7	6	30	9	13	9	4	2	1	1	2	1	1
1939		1		2	1	6	2	23	6	1	2				2			
1940				5	2	7	8	25	2	4	3		2					
Total	2	3	3	24	12	34	26	154	47	72	26	10	12	7	5	4	3	5

Yearly comparisons are difficult to make from this table, due to the variable number of deer killed and the overlapping of numbers in various classes. By combining the 1936 and 1937, and the 1939 and 1940, kills, and comparing them as two frequency curves (Fig. 1), it becomes apparent that the most frequent antler-class declined from 8 to 10 tines per head during the latter period.

Age Classes

Age-classes are based on the diameter of the antler beam according to the method worked out by Cahalane (1931, p. 286) for white-tailed deer in Michigan. Table 4 records the percentage of bucks in each of four age-classes for each year and for the total period.

Are
Wisco
taken

Are the chances for shooting a buck like this decreasing? Twenty-three per cent of the Wisconsin deer shot in 1936 and 1937 were ten pointers, while only six per cent of those taken in 1939 and 1940 were of that class.

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TABLE 4
AGE CLASSES

Age class (years)	1936 (174 deer)	1937 (62 deer)	1938 (107 deer)	1939 (46 deer)	1940 (58 deer)	1936–1940 (447 deer)
	% of total	% of total	% of total	% of total	% of total	% of total
1½	6	15	24	13	12	13
2½	22	16	21	28	34	23
3½–4½	46	32	33	37	40	39
5½ or over	26	37	22	22	14	25

Table 5 summarizes the occurrence of Michigan bucks in these four age-classes as given by Cahalane (1931, p. 288).

TABLE 5

Age class	*Percent of total*
1½	29
2½	23
3½–4½	32
5½	16

The proportions 23, and 39, per cent in the 2½ and 3½–4½ year age-classes, respectively, in both tables is a striking coincidence.

In Michigan, hunters shot almost as many bucks in the 3½–4½ and 5½ year age-classes as in Wisconsin. This similarity, despite our selective method of getting measurements, suggests a higher quality in Michigan bucks, probably due to a lower shooting intensity.

Park (1938, p. 278) found the same decline in number of older bucks with intense hunting in Pennsylvania. He says, "The buck law and the intensiveness of hunting . . . resulted in a gradual reduction in the number of older and larger male deer in the herd."

Table 6 combines the age-classes for 1936, 1937, and 1938 into one group, and those for 1939 and 1940 into a second group. Comparison of these two groups shows that there was an increased percentage of bucks killed in the 1½-year class during 1939 and 1940 while the percentage of bucks killed in the two older classes dropped off markedly.

TABLE 6
1936–1938 AGE CLASSES VS 1939–1940 AGE CLASSES

Age class (years)	1936–1938		1939–1940	
	Number of deer	% of total	Number of deer	% of total
1½	45	13	13	13
2½	71	21	33	32
3½–4½	135	39	40	38
5½ or over	92	27	18	17
Totals	343		104	

TABLE 7

Caliber	*Number of deer shot*
30-30	42
30 automatic	23
32 special	21
35 automatic	18
Buckshot	16
300	12
32 Remington	10
38-55	10
30-'06	9
351	6
32-40	5
8 mm.	4
401	4
38	4
30-40	3
25-20	3
7 other calibers	14 (each caliber shot 2)
11 other calibers	11 (each caliber shot 1)
	215

It appears that the decrease in weight

and in size of antlers was concurrent with decrease in the number of bucks shot in the older age classes.

MISCELLANEOUS

Incidental to this study, we found that hunters used 34 different calibers in more than three times that many makes of rifles and shotguns to shoot 215 of the bucks measured. Table 7 shows how many deer were shot with each caliber.

SUMMARY

1. Dressed weights of 108 bucks showed a decrease in average weight of 34 pounds between 1936 and 1940.

2. Fewer bucks with eight or more tines per head entered the hunter's bag in 1940 than in 1936.

3. With the decrease in weight and in antler size since 1936, there was a corresponding decline in the number of bucks of the older age classes.

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William H. Schunke
Black River Falls
Wisconsin

Irven O. Buss, Game Biologist
Wisconsin Conservation Dept.
Madison, Wisconsin

OBITUARY

Albert Rich Brand, financier and ornithologist, was born in New York City, October 22, 1889, and died at Ithaca, New York, of a lingering illness, March 28, 1940.

After graduating with honors from Public School 89, in New York City, he spent two years in Morris High School and a year and a half in the high school department of City College. Unable, for financial reasons, to continue his schooling, he entered the firm of E. D. Levinson & Co., Bond Brokers, in March, 1909, as a runner. In January, 1915, after six years of service, he was made a member of the firm, and in October of that year represented them on the New York Stock Exchange as bond broker and arbitrager.

In 1916 he married Ernestine Charlotte Isabel, of New York City. Four years later he became associated with E. H. Stern & Co., and was admitted to partnership in this firm in 1922. After six years he went into business for himself as arbitrager on the Exchange and was so successful that within four months, when only thirty-nine years old, he decided to sell his seat on the Exchange, to retire from business and devote the rest of his life to academic pursuits.

For a year he studied economics at Columbia University, but economics did not satisfy him and, in 1930, upon the advice of Dr. Frank M. Chapman, he entered Cornell University as a special student majoring in ornithology.

In February, 1933, after completing his undergraduate studies at Cornell, he was appointed Associate in Ornithology at the American Museum of Natural History in New York City, but three years later he returned to Cornell as Research Associate in Ornithology. Here he devoted himself to the study and recording of bird-songs, a project which he had started as an undergraduate, and he planned and financed expeditions to all parts of the United States, even after his health no longer permitted him to engage in field work himself.

In 1934 he published thirty-five of the first songs recorded. They were presented in the form of two small phonograph disks included in the back of a small book entitled "Songs of Wild Birds." This book was followed in 1936 by another similar volume, "More Songs of Wild Birds," containing three disks and forty-five songs, both published by Thomas Nelson and Sons. There were many mechanical difficulties in the production of these first records, with resultant imperfections, which recent improvements in the recorder and the record stock have practically eliminated, but the early records served a very useful purpose, representing as they did the first satisfactory mechanical reproductions of actual bird-songs.

In 1937 he learned of the work of the American Foundation for the Blind and their production of "Talking Books" and, upon invitation, was pleased to cooperate by writing two books (four phonograph records) with accompanying bird-voices—a project which has been received with great acclaim by the unfortunate people who can no longer see birds.

As early as 1935 he knew that he was

ever in imminent danger from an infection of the kidneys, with a maximum of ten years to live. Still through all his enforced confinement he was cheerful and helpful to the last, with an unflagging enthusiasm for the study of birds.

Albert Brand is survived by Mrs. Brand and three children—John, Charles, and Alice—and he is remembered by a host of friends for his ever cheerful disposition, for his broad interests, and his sympathetic understanding of human nature which endeared him to persons in all walks of life.

His pioneer work in recording bird-songs and studying the film records with a microscope are outstanding contributions to the science of ornithology and should be of great interest to students of wildlife management as demonstrating a method of reducing even that most evanescent of Nature's phenomena—the song of a bird—to scientific analysis.—Arthur A. Allen.

NOTE

The Wildlife Society has gone on record as favoring publication of a Manual of Wildlife Management Techniques and of a series of Monographs to accommodate papers too lengthy for use in the JOURNAL. These are worthy objectives but they can only be achieved with funds additional to those now available. The Society's receipts come largely from memberships and the hope of getting increased income to support the new publications appears to rest upon possible increase in the number of members. Soliciting members should not be left entirely to the regional representatives and other especially interested individuals but should be shared by all members of the Society. Each member must know some one or more persons who should be members of The Wildlife Society. If each should act upon his knowledge and bring one or more new members into our ranks, our capacity for publication would be doubled at once. Every member has a stake in the welfare of the Society and should work to insure it. Application blanks can be obtained from the Secretary. Building and maintaining membership in the Society is not a task to be left to the other fellow but is an obligation upon every member.

THE WILDLIFE SOCIETY

Report of the Secretary for the Year Ending with the Fifth Annual Meeting, February 18, 1941

During the past eleven months since the new Secretary took over his duties, he has come to appreciate sincerely the excellent work of Victor Cahalane, as Secretary of the Society during its first three years. I want to express my appreciation to him for the invaluable assistance he has given me in carrying on this office since last March. I wish also to thank the other officers, Regional Representatives, Committee Members, and the Editors of the Society's two publications for their continuous help in making the job of Secretary a pleasant one.

The total membership of the Society is now 839 (as of February 12th) composed of 350 Active members and 489 Associates. In addition there are 171 libraries, offices, and individuals subscribing to The Journal of Wildlife Management. These figures indicate a net loss of 40 Active members and 26 Associate members as compared with the previous year, and a gain of 36 in subscriptions. This loss may appear at first to be a serious reversal of the previously reported yearly increases in membership. Actually, however, it represents the results of the first weeding of members in arrears more than two years. Following last year's meeting, a final appeal was made to 11 Active members and 55 Associates who were in arrears since 1937. None responded and they were dropped from the rolls. The delinquents since 1938 total 31 Active, and 67 Associate members. These will be dropped from membership if they fail to pay up after another notice that will be mailed immediately. Since last year's appeal failed to bring any of the 1937 delinquents back into the fold, it is unlikely that the 98 delinquents since 1938 will respond much better. I have, therefore, not included these in the total membership as presented above, in order to give you a fairer picture of where we actually stand. The problem of delinquency remains one of considerable concern. Four members have resigned during the past year. Of the 839 members that remain on the rolls, 90, 9 active and 81 associate, have not yet paid their dues for 1940 or 1941. The Society cannot maintain its prestige or its Journal without the full support of its members.

More cheerful than the story of our losses of one-time members is the record of new applications and subscriptions. During the past year 67 associates or non-members have applied for Active membership. The Membership Committee made favorable recommendations to the Council on 30 of these applications and these received Council approval. The individuals elected are as follows:

Anderson, Harry G.
Benjamin, Joel R.
Berghuis, Dana P.
Clark, Arthur L.
Gigstead, Gilbert K.
Gould, Ernest W.
Grange, Wallace B.
Greene, Earle R.
Haugen, Arnold O.
Huntsman, Archibald G.
Jewett, Stanley G.
Jorgensen, Eldores S.

Lamb, Leonard D.	Potts, Merlin K.	Smith, Osgood R.
Leopold, A. Starker	Pritchard, Andrew L.	Tanner, James T.
Low, Seth H.	Radway, Merton	Thone, Frank K.
Meyer, William H.	Riter, William E.	True, Gordon H., Jr.
Mottley, Charles M.	Sack, Ivan	Twork, Elton C.
Nelson, E. Clifford	Schinkel, Peter H. W.	Van Dien, Walter P.

A total of about 78 new Associate Members were accepted during the year and about 36 new subscriptions to THE JOURNAL OF WILDLIFE MANAGEMENT were received.

It is clear that the annual accession of Active members has greatly declined from the 73 elected last year and correspondingly large numbers in previous years. This reflects that the original field of individuals qualifying for Active membership has now been well canvassed and that from now on our yearly election of new Active members will come largely from the ranks of those who have within the year reached qualification for this status. This number is not likely to be much larger in the years just ahead than it is this year. If we are to increase our resources through membership, it will have to come mainly from associates.

The Regional Representatives and the Secretary, with the particular help of W. L. McAtee, have kept going a continuous effort to increase our membership. A total of 201 typed letters of invitation were sent out by the Secretary alone. While this work has been reasonably successful in bringing in desirable numbers, it is our belief that more can be accomplished if each present member will take active steps to encourage all of his acquaintances who should be members to join the Society, and those who should take the JOURNAL to subscribe.

The increasing numbers of libraries subscribing to the JOURNAL is a commendation of both the JOURNAL itself and the Society.

The annual election of Regional Representatives was conducted as usual by mail. A nominating ballot was returned with December 21, 1940 as the deadline and the election ballot was closed January 18, 1941. The elections were:

Region	I	Richard Gerstell[1]
	II	Walter A. Gresh
	III	Harry D. Ruhl
	IV	Olaus J. Murie
	V	Adrey E. Borell
	VI	Daniel I. Rasmussen

The news-letter "Wildlife Society Information" completed its second year under the guidance of Leo Luttringer. It is with regret that Editor Luttringer will no longer be able to continue at the helm, but it is anticipated that publication will be continued under a new Editor. "Information" has been of great interest to the members and will be even more valuable in the future if all members will promptly send news notes, letters for publication, and other material for inclusion, to the Editor, or to the Secretary.

It is the sad duty of the Secretary to

[1] Mr. Gerstell being subsequently elected President, Dr. Logan J. Bennett who had the second largest number of votes became Regional Representative for Region I.

report the deaths of 4 members during the past year: Albert R. Brand, of New York; C. P. Fitch of Minnesota; William C. Kelley of Mississippi; and Robert H. Stobie of New Hampshire.

FRANK C. EDMINSTER
Secretary

REPORT OF THE TREASURER FOR THE CALENDAR YEAR 1940

The finances of the Wildlife Society have continued on a stable basis following the wise policies established by the Council in 1937. We have always maintained a balance of over $500 at the end of each year in order to

FINANCIAL STATEMENT
For the Year 1940

BALANCE (December 31, 1939)	$ 624.52	
RECEIPTS (From Active and Associate Members and Subscribers)	3,733.29	
TOTAL BALANCE AND RECEIPTS*		$4,357.81
DISBURSEMENTS:		
General Administration		
Stationery and printing	$ 91.59	
Postage, registered mail, telegrams, etc.	218.94	
Secretarial assistance	23.75	
Exchanges, returned checks, etc.	27.98	
Treasurer's bond	5.00	
Refunds	8.00	
Transfer Secretary's files (Washington, D. C., to Upper Darby, Pa.)	3.14	
Book (The Federal Civil Service)	1.90	
Publications		
JOURNAL OF WILDLIFE MANAGEMENT (4 issues)	2,940.02	
JOURNAL OF WILDLIFE MANAGEMENT (reprints, etc.)	17.59	
Wildlife Society Information (4 issues)	247.21	
TOTAL DISBURSEMENTS		$3,585.12
BALANCE (December 31, 1940)		$ 772.69

WARREN W. CHASE
Treasurer

* Total receipts are not a product of 1940 dues only, as these include some late 1937, 1938, 1939 and some early 1941 dues and subscriptions.

expedite payment for the October issue of THE JOURNAL OF WILDLIFE MANAGEMENT and meet other expenses that come toward the end of the year. When new dues come in early in the year we have an excess, but the decrease in income in later months makes it necessary to maintain a small balance. Our income has never been sufficient to make a separate Trust Fund possible.

Total income during 1940 was $3,733.29. Adding to this our 1939 balance of $624.52 we had a total of $4,357.81 available for use during the year. Of this, $3,204.82 was spent for publications. Four issues of THE JOURNAL OF WILDLIFE MANAGEMENT cost $2,940.02 plus an additional $17.59 for reprints. Four issues of Wildlife Society Information cost the society $247.21. General administrative costs were $380.30, most of which went for postage, stationery, and printing. Each year since 1937 administration costs have decreased about $200 a year, and it is likely that they will never be lower than the amount spent this year. A large part of this reduction is due to the increased unpaid assistance by the secretaries of the Treasurer and Secretary of the society.

Dues from members and income from subscribers have been coming in rapidly since January 1, 1941, and the society had, on February 5, 1941, a balance of $1,558.27.

REPORT OF THE COMMITTEE APPOINTED TO AUDIT THE ANNUAL REPORT OF THE TREASURER OF THE WILDLIFE SOCIETY FOR 1940

We, the undersigned members, have inspected the accounts of the financial transactions of The Wildlife Society for the year ending December 31, 1940, as kept by the Treasurer and as summarized in his annual report to the Society. While we have not conducted a complete audit, we have examined the records sufficiently to convince us that the accounts have been accurately kept and that the report, as submitted by the Treasurer, is correct in every substantial detail.

In the judgment of the Committee, a detailed professional audit was not justified in advance of this meeting of the Society. When a new Treasurer is elected, it is recommended that a professional audit of accounts be made at the time he assumes the responsibility of his office.

The Committee encountered a little difficulty in checking receipts against a list of members. This was due to the fact that the list of members compiled by the Secretary is kept current whereas the Treasurer's report is for the calendar year ending December 31, 1940. To complete the record, the Committee plans to follow up on this phase of the audit as soon as the membership, as of December 31, 1940, is segregated from the current record.

THE AUDITING COMMITTEE

February 27, 1941	R. R. Hill, Chairman
February 18, 1941	Willis King
March 10, 1941	Burton T. Ostenson

REPORT OF THE EDITOR FOR 1940

Volume 4 of THE JOURNAL OF WILDLIFE MANAGEMENT for 1940, contained 44 leading articles, 9 notes, 2 obituaries, 2 items of correspondence, 1 editorial (not by the Editor), and the proceedings of the Fourth Annual Meeting, totaling 452 pages and illustrated by 15 inserted plates and 66 text figures. Two supplements also were issued—one of 24 pages devoted to a list of officers, committees, and members of the Society, and another of 10 pages comprising a title page, table of contents, and index for volume 3.

Four numbers of Wildlife Society Information totaling 48 pages also were issued. These were mimeographed and distributed under the supervision of Leo A. Luttringer, Jr., of Harrisburg, Pa., to whom the thanks of the Society are due. Regrettably, pressure of other duties has compelled Mr. Luttringer to ask to be relieved from the work, so a new headquarters for Information must be found.

The Editor has continued to scrutinize contributions rather closely for expression, and has returned most of them to the authors for consideration of editorial suggestions and re-copying. Only a few, however, have been entirely rejected.

A great difficulty with papers on wildlife management is that a good many of them are from new authors who are anxious to make a showing of their work but who, in the rapid turnover still characteristic of the field, do not stay in one place long enough to make any very thorough study. The Editor accepts a good many papers because he realizes that the authors are not responsible for the lack of thoroughness, but on the other hand, he hopes that greater stability in employment or greater persistence on the part of authors will in the future result in more exhaustive work being done as a basis for published reports. Three to five year investigations are certainly to be preferred to those running for only as many months, as is also continuance of work until an amount of data has been assembled that will eliminate or average out seasonal differences. Longer periods spent in study and preparation also give time for reflection so that the end product is better rounded and thus more desirable.

The Editor would urge that publication in THE JOURNAL OF WILDLIFE MANAGEMENT, enabling authors to address a large proportion of the members of our rapidly growing profession, is a privilege that should be prized. It has been somewhat of a surprise to him that a good many authors of papers in the JOURNAL are not members of the Society, and more lamentably still, that a few who are members have allowed their dues to become delinquent. It seems to the Editor that anyone working in the field of wildlife management should not regard The Wildlife Society simply as another organization, one bringing an addition to a possibly already burdensome amount of membership dues, but it should be the No. 1 society to which others should be sacrificed if sacrifice is necessary. In fact, the Editor believes that if the isolated wildlife manager must choose, he should favor The Wildlife Society above

all others and the Editor further feels that it is an obligation upon everyone in the wildlife field to give loyal and full support to The Wildlife Society.

W. L. MCATEE
Editor

REPORT OF THE MEMBERSHIP COMMITTEE, 1940–1941

During the past year, the Membership Committee reconsidered 43 personal history statements of associate members. Of these, 4 were recommended for active membership. New applications totalled 67, of which 26 were recommended for active membership and 41 for associate. The tally is as follows:

Recommended for active membership	30
Recommended for associate membership	80
Sent to Council without recommendation	3
Total considered	113

For the first time, men who have majored in wildlife management and who have completed a full four years of study in this field, are now applying for membership. Because the grading system used by the Society so far was designed to treat an entirely different class of applicant, it is believed necessary to consider revising the system since increasing numbers of the new type of applicant may be expected. The Membership Committee recommends, therefore, that careful study be given the situation, preferably by this Committee.

It has also been noted that a certain number of applications are obviously no more than subscriptions to the JOURNAL. Therefore, the Committee believes it timely to consider the establishment of a subscribing member class in which may be placed not only those who wish merely to subscribe to the JOURNAL, but also those who are not qualified to become associate members. This implies that possibly a higher standing should attach to associate membership than at present. The Committee feels that only those applicants actually working in the field of wildlife management should be accorded associate membership. In turn, if this suggestion is accepted, a reconsideration of the amount of dues paid by the three classes will be in order.

The problems discussed in the above two paragraphs depend entirely upon any action taken by the Society with reference to the present membership system.

CLAUDEOUS J. D. BROWN
RICHARD GERSTELL
PHIL GOODRUM
E. LOWELL SUMNER, JR.
WILLIAM R. VAN DERSAL
Chairman

REPORT OF THE COMMITTEE ON PROFESSIONAL STANDARDS

There have been two principal accomplishments during the past year; one investigation is still under way; and one new line of consideration will be undertaken by the Committee during the coming year if the Society approves.

The investigation still under way, conducted by Ralph T. King, was be-

gun by another subcommittee in 1939. It represents an attempt to answer the question (*cf.* Annual Report 1940): "How close a correlation exists between a man's actual accomplishment on the job, as rated by his superiors, and several other things—*e.g.* his civil service examination-grade, scholastic rating, extracurricular experience, and the like?"

The first principal accomplishment was completion of a statement, "Objectives in civil service." This was prepared by Paul L. Errington, with comments and assistance by the entire Committee, which has approved the draft submitted herewith. It is intended to set forth a set of principles which may serve as a basis for the Society's attitude toward civil service as it affects wildlife work. The Committee believes that this statement, if made official by the Society, will announce the Society's general "platform" with regard to civil service in the same way as the Society's endorsement of the Leopold statement on academic and professional training last year did in the latter field. Only when groundwork of this sort has been laid will the Committee or the Society know when or where to proceed in these fundamental matters.

The second accomplishment was completion of a preliminary study of the extent and distribution of civil service procedures in state game or conservation departments. This was conducted by Ruhl and Hawkins, who obtained their information from two sources: the conservation departments themselves and the state civil service commissions. Their report, admittedly very general, classifies the procedures found as follows: (1) Statewide systems; (2) departmental systems; (3) no civil service procedures. Each of the first two has been subdivided as follows: (a) Formal, well-established, and seemingly satisfactory systems; (b) fair to good systems covering certain classes of employees; (c) relatively new but promising systems; (d) systems of doubtful merit or quality. The Committee proposes, unless otherwise instructed by the Society, to submit this report once more to the state departments for confirmation or for the correction of errors, and then to publish it as a matter of information.

The new line of consideration which the Committee proposes to undertake during the coming year is preparation for some sort of appraisal of the facilities available for training in wildlife conservation and management in the colleges and universities. It has been felt for some time that eventually this must become a responsibility of the Society, as in the case of professional organizations in other fields. The Committee believes, however, that no system of appraisal should be set up or put into operation without the approval of the Society. Therefore it proposes to gather information during the coming year and to plan how the appraisal might be made. The Committee feels that this should be done, when the time comes, by some method more satisfactory than merely depending on questionnaires. Several procedures have already been suggested, and additional suggestions from the membership will be welcomed by the Committee. For instance: What phases of training-programs should be considered? How and by whom should the appraisal be made? How detailed and on what basis should the "rating"

be made, if there is any rating at all? In what form should the report be presented, and to whom, if it is made public? These and many other questions have occurred to the Committee. If it is the sense of the Annual Meeting that preparations during the coming year for the presentation of a workable plan are unnecessary, unwise, or premature, the Committee requests instructions to this effect.

PAUL L. ERRINGTON
ARTHUR S. HAWKINS
CARL L. HUBBS
RALPH T. KING
ALDO LEOPOLD
H. D. RUHL
HERBERT L. STODDARD
WALTER P. TAYLOR
RUDOLF BENNITT,
Chairman

The following statement was made available to members of the Society at the Registration Desk of the North American Wildlife Conference. Following presentation of the above report, the Society took two actions: (1) Approval of the statement as submitted, for publication in the Journal of Wildlife Management with the endorsement of the Society; (2) approval of the Committee's report, including the plans for the coming year.

OBJECTIVES IN CIVIL SERVICE

Prepared by Paul L. Errington, with the assistance of, and endorsement of the other members of the Committee on Professional Standards, 1940.

The accepted purpose of a civil service system is, in brief, to insure an optimum combination of advantages for the public and the public's employees. Civil service attempts to safeguard the interests of the public through selection of employees on a merit basis and to safeguard in turn the interests of the employees through provisions concerning salaries, tenure, promotion, retirement, etc., and by protection against political or other interference or exploitation.

There is naturally less disagreement with the principles governing civil service than with the translation of those principles into practice—especially as relates to specific cases where decisions may not always be disinterested. Nevertheless, enough confusion results from honest divergence in viewpoints and the complexity inherent in big programs to make the need of criteria for judging current or proposed systems all the greater. Civil service is neither the only, nor, being a product of fallible human effort, conceivably, the best means of working for the common ends of the public and its employees, but it appears to be more worthy of consideration than any other medium now in sight.[1]

Appointment

Under civil service, government (including federal, state, and local) positions are filled chiefly through examinations. The effectiveness of this method is conditioned by how frequently the examinations are given and by how well they reveal an applicant's qualifications for the openings that exist; indirectly, by the qualifications of the persons preparing and grading the questions and the money and facilities available for

[1] The Committee is especially appreciative of courtesies shown it by President Roosevelt's Committee on Civil Service Improvement.

such purposes. Obviously, the more mechanical the method of handling examinations becomes, the less suitable it will be for choosing personnel for positions requiring special training or aptitude.

The examination for Junior Biologist has been singled out for attention by this Committee. Not only is it widely given, but the Society of American Foresters has also made a valuable study of the corresponding Junior Forester examination. To encourage the use of examinations that are practical to conduct and at the same time intelligently selective, the following desiderata are listed:

(1) Written examinations should be supplemented by oral interviews, or in similar ways, whenever the former alone are insufficiently selective.

(2) Examinations should test the applicant's ability to think and express himself, in addition to bringing out his knowledge of isolated facts, and should to a reasonable extent reflect technical advances in the fields covered. Misleading or unfair "catch" questions should be avoided, as should those to which correct answers may be guessed without either clear thinking or information.

(3) While fundamentals should be emphasized in all examinations, no single examination should be expected to demonstrate the full qualifications of applicants for duties in different, more or less specialized agencies. Optional questions should permit the applicant to show knowledge of particular subjects rather than aid him in concealing ignorance of things he might justly be expected to know.

(4) The importance of appraising character and personality of applicants should not be overlooked, notably when positions to be filled demand a high degree of cooperation.

(5) So far as possible, no credit should be allowed in examinations except for personal qualities, knowledge, training, and experience that enhance the applicant's fitness. If previous military status would be an actual asset on the job, it should be given weight in the examination but should not be used as a principal qualification for positions that could be satisfactorily filled without it.[2] Preference may well be given to residents when a position requires local knowledge or background, but place of birth or domicile should not unduly influence an applicant's chances for appointment.

(6) Examinations should, whenever feasible, be synchronized with the academic year of colleges and universities to equalize opportunities for graduating classes.

(7) Efforts should be made to correlate forms and questions of examinations with subsequent achievements of employees, in order that the selectivity of the examinations may be evaluated and improved.

(8) There should be regular integrating contact between the examining agencies and those employing and training men.

Mechanical examinations may always

[2] See Chapter XV, pp. 383–408, of the book by James E. O'Brien and Philip P. Marenberg, "Your Federal Civil Service" (Funk and Wagnalls Co., 1940), for a description of inequalities that may result from veterans' preference laws. The efficiency of a system can hardly fail to suffer as long as a veteran making an earned examination grade of 60% must be placed in an eligibility register ahead of a non-veteran making 100%.

be necessary but increasing emphasis should be placed upon statements of education, experience, and accomplishment, upon personality, and, most important of all, upon actual performance during a probationary period.

On the whole, the selection of employees by present civil service methods seems to be more necessary in large, than in small, organizations. "Civil Service" is no panacea. At its worst it is merely a camouflage for protected personal or political manipulation. At its best—and it is strictly in this sense that the term is here used—it means appointment on a fair basis where true merit in all of its many aspects is the only reason for appointment. Civil service, with the latter connotation, should be applicable at all levels, from custodian to chief biologist, department head, or bureau chief.

Tenure, Retirement, Advancement, and Elimination

Apart from filling government positions with qualified employees, a major function of civil service is to assure satisfactory personnel of good tenure, within the limitations of budgets and prescribed scopes of activity. This it does by preventing dismissal arbitrarily or for reasons of religious or political beliefs.

Adequacy of retirement provisions depends in large measure upon conditions of tenure and may afford one of the major attractions of civil service for prospective employees.

Advancement under civil service tends to be slow, even when the performance of the employee may show pronounced and continued improvement. When advancement does come, it often entails disproportionately more responsibility and sacrifice than compensation of any sort, monetary or otherwise.

Lack of funds may terminate employment under civil service as in any job; likewise employees may be dismissed because of misconduct. Elimination of unsatisfactory employees may be partially accomplished by probationary appointments,[3] but there is a definite feeling that too many civil service jobs are merely "held." In wildlife management particularly, a large number of positions created during the rapid expansion of the profession several years ago were filled by inadequately trained men. Some of the latter, by virtue of ability, self-education, and experience, are now unquestionably qualified for the work they do, but others are not, and these others, furthermore, occupy positions for which better-trained and abler men are available.

Although continuity of employment is requisite to "career" work and may be essential to the completion of long-term programs, a position once obtained should not thus catalogue a man indefinitely. The permanence of civil service jobs appears, in many cases, to have been attained through undesirable sacrifice of the culling and stimulating functions of penalties and rewards. Security and performance should be more in balance.

Opportunity for Productive Work

The realization of personal and public satisfaction in a civil service position

[3] It is problematical how accurately incompetence for a difficult position may be recognized in a probationary period of less than a year.

may or may not be synonymous, but the two are interlinked insofar as human beings must do the work and as their efficiency is affected by health and morale. Granted, so long as established principles are not violated, that the details of what employees actually do may be said to be an administrative matter and hence not in the province of civil service, it is evident that attainment of civil service objectives may be impeded by weaknesses in the administration of governmental organizations.

The rigidity and intricacy of procedure that we refer to as "red tape" was doubtless evolved partly in defense against abuses and partly for the sake of increasing efficiency. Large organizations manifestly need policies and a system to maintain order; but, as everyone knows, policies may have their faults, and a system can become so cumbersome that it diverts to its own operation most of the creative endeavor it is charged with furthering. Multiplication of imperfectly coordinated agencies is, of course, a source of complication.

No blanket criticism of working conditions in civil service jobs would be fair, if only for the reason that it would not be equally applicable. An impression is widespread, however, that in wildlife management and related activities the lower professional grades of biologists have to spend over-much time on reports, whereas the higher-ranking are too loaded down with the mechanics of administration; also, that excessive travel requirements and frequent changes in assignments may seriously detract from an employee's productivity. It is perfectly clear that not all persons in such positions feel burdened by any one of these things; others are able to do what they consider effective work principally after hours; still others say frankly that they simply cannot do more than "go through the motions."

In rebuttal, it is stated that those who complain about being swamped with reports or special assignments would not necessarily work to better advantage if they had more latitude, and that keeping the best-trained men in charge is essential to the success of a program. All this may perhaps be true, but there are legitimate questions as to how much wastage of significant effort occurs and how much the impersonality of an organization may needlessly force individuals into irksome or unsuitable tasks.

Attracting and Holding Superior Personnel

In general, the lower civil service ranks are relatively more attractive than the higher. Regardless of the excellent scientific standing of many government men, there are certainly many other scientists of comparable qualifications who would not, under any incentive short of compulsion, accept civil service positions.

Whether civil service or administration may be held responsible for the lament of eminent workers that specialized training and experience seem to lead only to desks at which clerical routine absorbs virtually all time and energy, government departments must offer inducement greater than a regular and passably adequate pay-check if they are to build up, and keep, a really outstanding personnel.

REPORT OF THE COMMITTEE ON ARRANGEMENTS

In the preparation of the program of Technical Sessions for the Sixth North American Wildlife Conference an effort was made to improve upon those previously offered. The policy, established a year ago, of scheduling the major topics on wildlife management on a rotation basis has been continued so that in time each topic may receive its due share of attention.

Even though criticisms have been directed at your committee, it is believed from the standpoint of the objectives of the Wildlife Society and of the National Wildlife Institute, which sponsors these meetings, that progress is being made.

Soon after the Fifth North American Wildlife Conference, in March, 1940, the Committee on Arrangements began to plan the program for 1941. In order to select topics that would meet with the approval of The majority of the members of the Wildlife Society, the Committee sent out postal cards requesting suggestions as to preferences. Many of the cards were not returned, many were incorrectly marked, and many of those returned were received long after the appointed date for making up the program. Results from this attempted survey were certainly disappointing.

On account of the apparent lack of interest on the part of members of The Wildlife Society, and because constructive recommendations were received from persons not belonging to the Society but who are sincerely interested in wildlife conservation and research, we question the advisability of having the committee selected solely from this organization. We believe that persons representing other organizations should play a part in the planning of the Technical Sessions.

During the latter part of the past year a change was made in the secretaryship of the American Wildlife Institute and the Committee further delayed formulating the program until it could confer with J. Paul Miller, the new secretary, in order to develop a program that would be harmonious with the general plan of the Conference. Two marked changes were made this year: First, reduction in the number of papers for presentation at each technical session to five or not more than six, and allotment of an additional 15 minutes for discussion following each paper. The effect of specifically designated discussion leaders also is being tried. Your committee believes that papers should be of moderate length and upon a regional basis rather than upon localized researches, which are of little interest to the majority of the audience or of the readers of the published proceedings. Your committee believes that the subjects for technical sessions may well be announced a year in advance.

An important point for the future committee is to be on guard against the destructive criticism of inexperienced counselors. As an example, it has been proposed that the topics for the future meetings be posted a year in advance in order that prospective authors could direct research toward these subjects. We believe that a year's research so planned and directed would in most instances be inadequate.

It is notable that those who offer the most profuse suggestions to the com-

mittee on the proper manner of arranging a program and for conducting a meeting are the most delinquent and unreliable in getting material ready when given a place on the program.

Your committee believes that to qualify for the Technical Sessions, papers should be based upon studies of several years' duration or should review management subjects on a state or regional basis. It is regrettable that due to restriction of the program many good papers could not be accepted.

The Committee appreciates the helpful cooperation of the Secretary of the American Wildlife Institute (J. Paul Miller) in affording many conveniences in connection with this meeting, as well as in furnishing assistance in handling correspondence.

In order that the Committee on Arrangements appointed for the meeting in 1942 may have the benefit of our experience, we take the opportunity to mention topics that appear to have an important bearing on current wildlife conservation and research. In so doing we have endeavored to suggest topics that are of vital interest to conservation officials and technical workers. Choice of topics has been made to cover the field of research when rotated over a period of years and we believe that those proposed for consideration by the committee for 1942 are significant in progressive conservation plans. It should be understood that these are merely suggestions and are in no way put forward as binding upon the committee for next year.

Suggested Topics for Technical Sessions

1. Competition of domestic stock and wildlife.
2. Technical aspects of law enforcement.
3. Pollution as a factor in wildlife management.
4. Pollution as a factor in fish management.
5. The economics of hatching salt-water fishes.
6. Control of noxious vegetation on wildlife areas.
7. Controlled burning as a factor in wildlife management.
8. To what extent aré fish hatcheries justified?
9. Propriety and results of stocking game.
10. Administration of fisheries programs.

THOMAS H. LANGLOIS
BARRY C. PARK
PHILIP A. DUMONT
J. E. SHILLINGER, *Chairman*

MINUTES OF THE FIFTH ANNUAL MEETING AT MEMPHIS, TENN., FEBRUARY 18, 1941

The meeting was called to order by President Cahalane at 8:50 P.M., with approximately 80 members present.

The reading of the minutes of the previous meeting was dispensed with and the printed minutes as given in the July 1940 issue of THE JOURNAL OF WILDLIFE MANAGEMENT accepted.

The report of the Secretary was distributed as mimeographed, and changes

in the printed form, including the list of new Active Members, given. The report was accepted.

The report of the Treasurer was read, followed by that of the Auditing Committee; both were accepted.

The Regional Representative's reports were given; Hosley's was read by the Secretary. Davison reported extemporaneously and recommended to his successor the organization of local group meetings of Wildlife Society members in Region II. Ruhl reported verbally and recounted the autumn meeting of the mid-Western Wildlife Conference at Urbana, Illinois. Kalmbach also reported extemporaneously. Taylor read his report, including a summary of the Section meeting held in Texas. There was no report from Regional Representative Dixon.

In the absence of Chairman Skiff, the report from the Northeast Section of the Society was summarized by the Secretary.

The work of the Council of the Society was taken up item by item with the following actions:

The recommendation of the Council concerning a Manual of Wildlife Management Techniques was approved.

The question of representation of The Wildlife Society in determining time, place, and arrangements for future Wildlife Conferences was discussed. It was moved by Cottam and seconded by Gerstell that the action of the Council be approved. Carried.

The matter of number of copies of THE JOURNAL OF WILDLIFE MANAGEMENT being increased to a surplus of 300 plus current needs was discussed. It was moved by E. Komarek and seconded by Logan Bennett that the Council's action be approved. Carried.

The new policy covering the issuance of the Society's house organ was discussed at some length. The recommendations of the Council for the handling of the house organ were approved.

The re-appointment of Mr. McAtee as Editor of THE JOURNAL OF WILDLIFE MANAGEMENT was approved.

The question of classification of membership was discussed at great length. It was finally moved that the recommendation of the Council be followed. This motion was seconded and carried. The action of the Council in re-affirming the present method of electing officers was sustained.

The action of the Council in maintaining a separate Secretary and Treasurer was approved. The question of making an award each year to the author or authors of a paper designated by the Awards Committee as the outstanding paper in the field of wildlife management and ecology was debated at some length, and upon motion, the policy of the Society, as set up at the 1940 meeting, to make an award for an outstanding piece of writing was approved.

The action of the Council in recommending that the new President appoint a committee to investigate the feasibility of a Society symbol was discussed briefly. It was moved by Wade and seconded by Logan Bennett that the action of the Council be rejected. The motion was carried.

The action of the Council in recommending to the new Treasurer that notices for annual dues be sent out in October immediately after the comple-

tion of the volume of the Journal was discussed and sustained. The action of the Council in continuing in good status members called to defense duty was approved.

The action of the Council for the extension of the work of the Committee on Professional Standards toward making an inventory of teaching facilities for the profession of wildlife management was sustained. The action of the President in replying to Mrs. Edge concerning her request for funds for the Trumpeter Swan campaign was approved. The action of the Council in recommending that authors in THE JOURNAL OF WILDLIFE MANAGEMENT be members of the Society, with exceptions as noted, was sustained. The action of the Council concerning a series of wildlife management monographs was approved. The Membership Committee nominees, namely, E. Lowell Sumner, Jr., as Chairman, William J. Hamilton, Jr., John A. Johnson, and Thomas H. Langlois, were elected. The Membership Committee's action in passing on candidates for active membership was recounted and its approval by the Council sustained.

The Report of the Committee on Arrangements was received and filed.

The Report of the Resolutions Committee was read by Chairman Dalke. The following actions were taken on resolutions:

Whereas, the basic sources of strength in any nation are primarily its natural resources, including soils, water, forage, forest, wildlife, minerals, and human life, and

Whereas, the proper conservation and regulation of these basic natural resources and of agricultural production constitute an essential item in a proper and adequate defense, and

Whereas, the farmers and ranchmen and various communities of the entire nation are in urgent need of increased cooperation and help from the technical agencies, State and Federal, concerned with agriculture, forestry, range management, and conservation, be it,

Resolved, That the members of The Wildlife Society in convention assembled, Memphis, Tennessee, February 18, 1941, do hereby deplore the tendency recently noticed in Congress toward cutting appropriations for such vital services as the Soil Conservation Service, the United States Forest Service, and other agencies, and are unanimously of the opinion that this is a backward step in the great program of conservation and agricultural development so necessary to the nation in the present emergency, and be it further

Resolved, That the members of The Wildlife Society do hereby urge the National Congress and the President of the United States, in this critical time, to strengthen in all possible ways the work of conservation and agriculture, and especially through the appropriation of adequate sums for the effective conservation of all our basic natural resources, whether in soils, water, forage, forest, wildlife, minerals, or human life, and be it further

Resolved, That copies of this resolution be sent to each member of Congress and the President of the United States.

Passed.

Be it Resolved, That The Wildlife Society does hereby request the U. S. Civil Service Commission to consider incorporating questions on wildlife management in the examination for

junior agronomist, junior forester, junior range examiner, junior entomologist, junior veterinarian, and all others dealing with wildlife and land use.

It was moved to refer this resolution to the Committee on Professional Standards for its consideration; carried.

Whereas, there is outstanding need for an increased number of workers in the agricultural field who need a real knowledge of wildlife and its true relationship to agriculture, and whereas, there are a great number of county agents, vocational agriculture teachers, soil conservationists, foresters, and leaders in agriculture generally, who have not as yet joined the great wildlife conservation movement, therefore be it

Resolved, That the Wildlife Society in convention assembled at Memphis, Tennessee, February 18, 1941, hereby requests the presidents and deans of all colleges and universities giving courses in wildlife conservation to take all proper and necessary steps to interest larger numbers of the agricultural student body in this type of work, not as a vocation or profession, but as a necessary supplemental course to enable these men to properly meet the wildlife problems they will inevitably have to handle.

Comment: It is clearly understood that the number of professional workers in wildlife management is as large as desirable already, but that there is a great need for an increase in the number of active and energetic leaders such as county agents, vocational agriculture teachers, soil conservationists, and others in developing, strengthening, expanding, and applying wildlife conservation.

Most of the emphasis, to date, both by student and faculty, has been put on wildlife management as a vocation. From now on the larger emphasis should be placed on the desirability of one or more courses in wildlife conservation for every student in agriculture, forestry, and all related curricula in the college or the university.

This resolution was approved.

Resolved, That The Wildlife Society in convention assembled, Memphis, Tennessee, February 18, 1941. express appreciation to the management of the Peabody Hotel for the use of the facilities of the building and the hospitality extended to the members of the Society during the 6th North American Wildlife Conference. This resolution was carried.

Walter Taylor read a letter from a field biologist concerning the re-classification of Soil Conservation Service biologists to the classification of Conservationist. A motion was made and carried that this problem be studied by the Committee on Professional Standards and action in the form of a resolution by the Standards Committee be authorized as they see fit.

Gerstell submitted a resolution that was properly seconded, instructing the Secretary to thank the American Wildlife Institute for its cooperation in facilitating the program of the Wildlife Society: carried.

The Report of the Editor was read, accepted, and ordered printed in THE JOURNAL OF WILDLIFE MANAGEMENT.

The Report of the Committee on Professional Standards was read by Chairman Bennitt. R. Bennitt moved, and it was properly seconded, that the Errington report on Civil Service Standards submitted by the committee

be approved by the Society and printed in the Journal. This motion was carried. Skiff moved that a copy of the document be transmitted to all State and Federal Civil Service Commissions. This motion was properly seconded and carried. It was moved by Van Dersal and seconded by Gerstell that the report of the committee be approved in full. This motion was carried.

The Report of the Membership Committee was summarized by Van Dersal and the full report submitted. It was approved. The Report of the Committee on Employment was summarized by Dr. Wing and submitted in full. It also was approved. The Report of the Committee on Awards was read by the Secretary and the citation for the most outstanding paper in the field of wildlife ecology or management for 1940 made to authors Paul L. Errington, Frances Hamerstrom, and F. N. Hamerstrom, Jr., for their paper, "The Great Horned Owl and Its Prey in North Central United States."

E. Komarek made a motion to commend President Cahalane for his five years' work for the Wildlife Society. The motion was seconded and carried.

Election of Officers.—The Nominating Committee made its recommendations for Officers of the Society. The results of elections were as follows:

For President, Richard Gerstell
For Vice-President, Walter P. Taylor
For Secretary, Frank C. Edminster
For Treasurer, Lee E. Yeager
For Trustee, William L. Finley was renominated.

Adjourned 12:35 A.M.

FRANK C. EDMINSTER
Secretary

THE JOURNAL OF WILDLIFE MANAGEMENT

The JOURNAL will appear quarterly in January, April, July, and October. Subscriptions are at the rate of $3.00 a year, payable in advance; single copies, 75 cents each. Remittances should be made payable to The Wildlife Society, and sent to the Secretary, Frank C. Edminster, Soil Conservation Service, Upper Darby, Pa.

Manuscripts, and correspondence about them, should be addressed to the Editor, W. L. McAtee, The Wildlife Service, Washington, D.C. The JOURNAL will be devoted primarily to original articles of the highest quality obtainable, bearing on wildlife research, management, and administration along sound biological lines. Critical reviews, and discussions of the principles and philosophy of wildlife management and papers bearing on protection of the interests of The Wildlife Society and its members also will be welcome, but speculations, prophecies, or accounts of untried plans, will, in general, be eschewed. Acceptance of manuscripts for printing will be on the understanding that the material has not been published, or accepted for publication, elsewhere. Printed pages available to biological contributions are too few to justify duplicate presentations. Authors will be expected to prepare abstracts of their papers for Biological Abstracts.

At its meeting of February 16, 1941, the Council ruled that with the exception of papers especially approved by the Editor and President, no contributions shall be published in the JOURNAL unless the author (or one of joint authors) is a member of The Wildlife Society in good standing.

Authors of papers accepted for THE JOURNAL OF WILDLIFE MANAGEMENT please note carefully all attachments received with proof from the printer. There is a blue request for an *abstract* and a blue form on which it may be written or typed; this form when filled out is to be returned to the EDITOR. Please note the rubber-stamped notice in red that *both the original manuscript and the corrected proof* must be sent to the EDITOR. That request is repeated on a white sheet which also quotes prices for reprints and includes a form for ordering them. A yellow notice to authors of illustrated papers gives information as to how the engravings of plates and figures and the original drawings or photographs can be obtained. *All correspondence relative to reprints, originals of illustrations, and cuts should be addressed to the* PRINTER.

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Covers for reprints of the same stock as that used for the JOURNAL will be furnished at $3.85 for the first hundred and $1.40 for each additional hundred.

Postage on all reprint shipments is additional.

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THE WILDLIFE SOCIETY

Objectives. The objectives of the Society are: (a) Establishment of professional solidarity and maintenance of the highest possible professional standards; (b) development of all types of wildlife management along sound biological lines; (c) publications to effect these ends; (d) protection of the interests of its members.

Membership. Active Membership, requiring election by the Council, is open to persons professionally engaged in the practice or teaching of wildlife management, in wildlife administration, in wildlife research or in graduate study of these subjects, who is a graduate of a school approved by the Council; or who, in the opinion of the Council, has acquired an understanding of wildlife work comparable to that required by an approved school.

Associate Membership is open to any interested person who is sponsored by two Active Members.

Dues. Dues for Active Members are $5.00, and for Associate Members $3.00, annually.

Council. The governing body of the Society is the Council, composed of the four Officers and one representative from each of six regions in the United States. Provision is made for additional regions in other countries as the need arises.

Officers. The Officers elected for 1941 are:

President, Richard Gerstell, Pennsylvania Game Commission, Harrisburg, Pa.
Vice-President, Walter P. Taylor, Faculty Exchange, College Station, Texas.
Secretary, Frank C. Edminster, Soil Conservation Service, Upper Darby, Pa.
Treasurer, Lee E. Yeager, Illinois Natural History Survey, Urbana, Ill.

Regional Representatives:

Regional 1 (northeast), Logan J. Bennett, Pennsylvania State College, State College, Pa.
Region 2 (southeast), Walter A. Gresh, 802 Clemont Drive, N.E., Atlanta, Ga
Region 3 (north central), H. D. Ruhl, Department of Conservation, Lansing, Mich.
Region 4 (northern Great Plains), Olaus J. Murie, Jackson, Wyo.
Region 5 (southwest), Adrey E. Borell, Soil Conservation Service, Albuquerque, N. Mex.
Region 6 (west), D. I. Rasmussen, State Agricultural College, Logan, Utah.

Applications for membership should be made to the Secretary who will supply forms on which may be recorded the information required for classification. Inquiries on all subjects other than the JOURNAL should be addressed to the Secretary, Frank C. Edminster, Soil Conservation Service, Upper Darby, Pa.

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